159525

U.S. Department
Of Transportation
National Highway Traffic Safety Administration

NHTSA-2001-8011-29

People Saving People
http://www.nhtsa.dot.gov

PRELIMINARY ECONOMIC ASSESSMENT

FMVSS NO. 139

PROPOSED NEW PNEUMATIC TIRES FOR LIGHT VEHICLES

Office of Regulatory Analysis and Evaluation
Plans and Policy
October 2001

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This Preliminary Economic Assessment (PEA) provides an assessment of the costs, benefits, and other impacts of the proposed Federal Motor Vehicle Safety Standard (FVMSS) No. 139, which upgrades the standards for new pneumatic tires for light vehicles.

Proposed Requirements

The agency is proposing six tests: an upgrade in the high speed and endurance tests, new test procedures for the bead unseating test and road hazard impact test, and new tests for aging and low tire pressure.

The agency considered and analyzed in this PEA three alternatives for the high-speed test, three alternatives for the endurance test, and two alternatives for the low tire pressure test. The development of these alternatives has been an evolutionary process examining test results and the potential impact on the tire industry. The agency has decided to propose Alternative 2 of the high-speed test, Alternative 2 of the endurance test and both of the low tire pressure tests for comment. Only one of the low tire pressure tests will be required by the final rule.

The following table shows our best estimates, based on very limited testing, of the average percent of light vehicle tires (P-metric and LT-tires) that would pass the tests analyzed.

Percent of Light Vehicle Tires Passing Alternative Requirements

		Alternative 1	Alternative 2	Alternative 3
High Speed Test		100	88	65
Endurance Test		100	80	40
Both Tests		100	67	33
Low Pressure – High Speed	70			
Low Pressure – Endurance	100			
Combined High Speed Test Endurance Test Low-Pressure – High Speed		70	64	33
Combined High Speed Test Endurance Test Low-Pressure – Endurance		100	67	33

Benefits

Over 23,000 tow-away crashes per year are caused by blowouts or flat tires. There are an estimated 414 fatalities and 10,275 injuries in these crashes. The benefit of this proposed rule is to increase the strength, endurance, and heat resistance of tires.

It appears from the limited testing the agency has performed on tires, that about one-third of all tires would fail the proposed tests in this NPRM. The agency estimates that the benefits of the proposed alternatives for the high speed and endurance tests are 27 lives saved and 667 injuries reduced annually when all tires on the road meet the proposed requirements.

Not all benefits could be quantified. The agency believes there will be other benefits that could not be quantified currently from the aging test and overloading of vehicles and that there could be benefits from the low tire inflation test, the upgraded road hazard test, and the de-beading test.

Anticipated Costs

The agency believes the proposal (Alternative 2 for high-speed and endurance) will result in some P-metric tires with UTQGS grades of C and B for temperature resistance and some light truck LT tires being redesigned or taken off the market. These tires are typically the lowest priced tires on the market. The price increase for these tires is difficult to estimate. The agency's preliminary estimate is an increase of $3 per tire for those tires that fail the proposed high speed and endurance tests.

For the proposed Alternative 2 for high-speed and endurance, the average new vehicle price increase is estimated to be $4.09 per vehicle. There are an estimated 287 million light vehicle tires sold per year. Included in this estimate are new vehicle tire sales and aftermarket tire sales, but excluding temporary spare tires, which we are not proposing have to meet the proposed tests. We estimate that 32.8 percent of these tires would have a $3 price increase per tire. Thus, the total annual cost is estimated to be $282 million.

If Alternative 3 for high-speed and endurance were chosen, the average cost increase per tire is expected to be much higher.

Based on our limited testing, production variability may be the biggest problem for the manufacturers, requiring them to change tire designs to make sure that they will pass the required tests. In several of the tire models we tested, four of the five tires of a specific model passed the test, but the fifth tire failed.

Lead Time

The agency is proposing to make the requirements effective September 1, 2003, for P-metric tires, and September 1, 2004 for LT tires. An alternative three year phase-in schedule is also being considered: 50 percent of P-metric tires by September 1, 2003, all P-metric tires by September 1, 2004, and all LT tires by September 1, 2005.

I. INTRODUCTION AND BACKGROUND

A. Bridgestone/Firestone Recall

In 1990, Bridgestone/Firestone (BF) began production of a specially-designed, 15-inch ATX tire to be used as original equipment on the Ford Explorer that was being introduced in the 1991 model year. This tire was used as original equipment on several other Ford models and was sold directly to consumers as a replacement tire. A redesigned version of the tire was introduced in both 1995 and 1996 when the tire was renamed with two names, the ATX II and the Wilderness AT.

In 1996, BF started to receive a large number of claims relating to the 15-inch version of these tires. Most claims involved allegations of tread separations in which the tread and one of the steel belts separated from the other steel belt and carcass. Then in mid-1997, Ford dealers in the Middle East began to report similar problems with the 16-inch Wilderness AT tires. Testing conducted by Ford and BF led to limited recall actions in the Middle East, Venezuela, Malaysia, and Thailand in late 1999. In March 2000, the National Highway Traffic Safety Administration (NHTSA) opened an initial inquiry after 25 complaints were received between 1999 and 2000.

In May 2000, NHTSA opened a defect investigation into approximately 47 million ATX, ATX II, and Wilderness AT tires manufactured by BF, and issued a letter to Ford and BF requesting information about the high incident of tire failure on Ford Explorers. During July, Ford obtained and analyzed the tire failure data. The data revealed that the 15 inch ATX, ATX II and Wilderness AT tires had a very high failure rate, where the tread peels off. Many of these tires were made at the Decatur, Illinois plant. When the tires failed, many of the vehicles rolled over resulting in serious and fatal injuries to the occupants.

In August 9, 2000, BF announced the voluntary recall of all Firestone Radial ATX and Radial ATX II tires in the size P235/75R15 produced in North America, and Wilderness AT tires in the size P235/75R15 produced at the Decatur, Illinois plant. According to BF there were approximately 14.4 million of these tires produced, and they estimated the recall would involve 6.5 million tires still in use. That estimate included 3.8 million Radial ATX and ATX II tires and 2.7 million Wilderness AT tires. It was believed that these tires accounted for the majority of the tread separations being reported. The recalled tires were supplied as original equipment on many SUVs, including:

1991-2000 Ford Explorers
1996-2000 Mercury Mountaineers
1991- 2000 Ford Rangers
1991-1994 Ford F-Series
1991-1994 Ford Broncos
2001 Ford Explorer Sport Tracs
1994-2000 Mazda B Series
1991-1994 Mazda Navajos

After a four month analysis, BF announced that a certain group of their tires, primarily on Ford Explorers, may have been more likely to experience tread separations. This increase in tread separations in extreme cases was caused by several factors acting in combination. These factors were the tread design of the P235/75R15 tires, certain manufacturing factors related to the Decatur, Illinois manufacturing plant, and external factors on Explorers, including low tire inflation pressure and overloading of the vehicle.

Ford had recommended a tire inflation pressure for their SUVs of 26 psi, which was less than the 30 psi inflation pressure recommended by BF. Both of these recommended inflation pressures are less than the "maximum inflation pressure" marked on the sidewall of the tire. Most vehicle manufacturers recommend tire inflation pressures that are less than the maximum pressure marked on the tire sidewall. Many manufacturers recommend pressures less than the tire manufacturer's recommended pressure. These slightly lower tire pressures can create greater traction which improves the vehicle's handling and stability. However, the greater traction is due to the increased friction between the tire and the road, which generates more heat in the tire, that can contribute to the failure of marginal performing tires. After the recall on September 24, 2000, Ford announced that it was informing its SUV owners to inflate their Firestone tires to 30 psi, which is the BF recommended pressure.

Congressional investigators found evidence that BF knew their tires had serious defects in 1996, when 8 of 18 tires pulled from the production lines failed high speed tests. Seven of these failed tires were made in the Decatur plant. The Congressional inquiry eventually led to the Transportation Recall Enhancement, Accountability and Documentation **(TREAD)** Act of November 2000. The Act provided stronger penalties, longer recall periods, enhanced enforcement authority and increased funding to enable the agency to move vigorously with its defects investigations, to protect the public from the danger of defective products. The Act also specifically directed the agency to upgrade the tire safety standards, improve tire labeling information, and mandated that low tire pressure warning systems become required equipment on vehicles within two years.

B. TREAD Act requirements for upgrading tire standards

The TREAD Act, Section. 10, Endurance and resistance standards for tires states, "The Secretary of Transportation shall conduct rulemaking to revise and update the tire standards published at 49 CFR 571.109 and 49 CFR 571 119. The Secretary shall complete the rulemaking under this section no later than June 1, 2002."

C. Current Tire Standards - FMVSS No. 109/110/117/119/120/129

The present tire standards: FMVSS No. 109; New pneumatic tires, FMVSS No. 110; Tire selection and rims; FMVSS No. 119; New pneumatic tires for vehicles other than passenger cars; and FMVSS No. 120; Tire selection and rims for vehicles other than passenger cars, were established over thirty years ago before radial tires were introduced into the market, and have remained virtually unchanged.

FMVSS No. 109, *New Pneumatic Tires – Passenger Cars*, 49 CFR 571.109, specifies the requirements for all tires manufactured for use on passenger cars manufactured after 1948. This standard, which was issued in 1967 under the National Traffic and Motor Vehicle Safety Act (Safety Act), specifies dimensions for tires used on passenger cars and requires that the tires meet specified strength, resistance to bead unseating, endurance, and high speed requirements, and be labeled with certain safety information. FMVSS No. 109 applies to passenger car (P-metric) tires produced for use on passenger cars, light trucks, and multipurpose passenger vehicles (MPVs), including sport utility vehicles (SUVs). The standard was adopted in January

1968 from the Society of Automotive Engineers (SAE) recommended practice J918c, *Passenger Car Tire Performance Requirements and Test Procedures*, which was first issued by the SAE in June 1965.

The current FMVSS No. 109 includes four performance requirements for tires: a **strength test** that evaluates resistance to puncture in the tread area, a resistance to **bead unseating test** that evaluates how well the tire bead is seated on the rim, an **endurance test** that evaluates resistance to heat buildup when the tire is run at 85%, 90%, and 100% of its rated load nonstop for a total of 34 hours in an under-inflated condition, and a **high speed test** that evaluates resistance to heat buildup when the tire is run at 88% of its maximum load at speeds of 75 miles per hour (mph), 80 mph, and 85 mph for 30 minutes at each speed. The FMVSS No. 109 performance requirements are discussed further in Chapter II.

For the purposes of testing tires to determine their compliance with these standards, several variable factors such as the tire's inflation pressure, the load on the tire, and the rim on the tire on which a tire is mounted, must be specified. The agency specifies a limited number of permissible inflation pressures (or wheel sizes, in the case of the bead unseating test) to facilitate testing. The standard requires that each passenger car must have a maximum permissible inflation pressure labeled on its sidewall (S4.3). Section 4.2.1(b) lists the permissible maximum pressures: 32, 36, 40, or 60 pounds per square inch (psi) or 240, 280, 290, 300, 340, 350, or 390 kiloPascals (kPa). A manufacturer's selection of a maximum pressure has the effect of determining the pressures at which its tire is tested. For each permissible maximum pressure, Table II of the standard specifies pressures at which the standard's tests must be conducted. The intent of this provision is to limit the number of possible maximum inflation pressures and thereby reduce the likelihood of having tires of the same size on the same vehicle with one maximum load value but with different maximum permissible inflation pressures.

Closely related to FMVSS No. 109 is FMVSS No. 110, *Tire Selection and Rims - Passenger Cars*, 49 CFR 571.110, which requires that each passenger car be equipped with tires that comply with FMVSS No. 109, that tires on all cars be capable of carrying the load of that vehicle, that the rims on the car be appropriate for use with the tires, and that certain information about the car and its tires appear on a placard in the passenger car. FMVSS No. 110 also establishes rim dimension requirements and further specifies that in the event of a sudden loss of inflation pressure at a speed of 60 miles per hour, rims must retain a deflated tire until the vehicle can be stopped with a controlled braking application. FMVSS No. 110 initially became effective in April 1968.

FMVSS No. 117, *Retreaded pneumatic tires*, 49 CFR 571.117, establishes performance, labeling, and certification requirements for retreaded pneumatic passenger car tires. Among other things, the standard requires retreaded passenger car tires to comply with the tubeless tire resistance to bead unseating and the tire strength requirements of FMVSS No. 109. FMVSS No. 117 also specifies requirements for the casings to be used for retreading, and certification and labeling requirements. FMVSS No. 117 initially became effective in January 1972.

FMVSS No. 119, *New pneumatic tires for vehicles other than passenger cars*, 49 CFR 571.119, specifies performance and labeling requirements for new pneumatic tires designed for highway use on multipurpose passenger vehicles, trucks, buses, trailers and motorcycles manufactured after 1948. Under this standard, each tire has to meet requirements that are qualitatively similar to those in FMVSS No. 109 for passenger car tires. The high speed performance test in this standard only applies to motorcycle tires and to non-speed-restricted tires of 14.5-inch nominal rim diameter or less marked load range A, B, C, or D. But, FMVSS No. 119 does not contain a resistance to bead unseating test. The FMVSS No. 119 performance requirements are discussed further in Chapter II.

A tire under this standard is generally required to meet the performance requirements when mounted on any rim listed as suitable for its size designation, at the time of the tire's manufacture, as specified by the tire and rim associations publications that are listed in the standard. Further, the tire is required to meet the dimensional requirements when mounted on any such rim of the width listed in the load-inflation tables of this standard. In addition to the permanent marking for any non-matching listed rims, each tire manufacturer is required to attach to the tire, for the information of distributors, dealers and users, a label listing the designations of rims appropriate for use with the tire. FMVSS No. 119 initially became effective in September 1974.

FMVSS No. 120, *Tire Selection and rims for motor vehicles other than passenger cars*, 49 CFR 571.120, requires that vehicles other than passenger cars equipped with pneumatic tires be equipped with rims that are listed by the tire manufacturer as suitable for use with those tires, and that rims be labeled with certain information and establishes that these vehicles shall be equipped with tires and rims that are adequate to support the fully-loaded vehicle.

FMVSS No. 120 was promulgated January 19, 1976 (41 FR 3478, January 26, 1976), and became effective in August 1976. The primary effect of Standard No. 120 is fulfillment of § 202 of the Act by specification of the minimum load-carrying characteristics of tires not already subject to the passenger car tire and rim selection requirements of FMVSS No. 110. The rim selection requirements were limited to the use of a rim designated as suitable by the tire manufacturer for use with its product. The use of "DOT" labeled rims was required on and after September 1, 1979.

Tire selection under FMVSS No. 120 consists of two elements. With one exception, each vehicle must be equipped with tires that comply with FMVSS No. 119 and the combined load ratings of those tires on each axle of the vehicle must at least equal the gross axle weight rating (GAWR) for that axle. If the certification label lists more than one GAWR-tire combination for the axle, the sum of the tires' maximum load ratings must meet or exceed the GAWR that corresponds to the tires' size designation. If more than one combination is listed, but the size designation of the actual tires on the vehicle is not among those listed, then the sum of the load ratings must meet or exceed the lowest GAWR that does appear.

FMVSS No. 120 also contains a requirement related to the use of passenger car tires on vehicles other than passenger cars. The requirement states that when a passenger car tire is installed on a multipurpose passenger vehicle, truck, bus, or trailer, the tire's load rating must be reduced by a factor of 1.10, i.e., by dividing by 1.10 before determining whether the tires on an axle are adequate for the GAWR. This 10 percent de-rating of P-metric tires provides a greater load reserve when these tires are installed on vehicles other than passenger cars. The reduction in the load rating is intended to provide a safety margin for the generally harsher treatment, such as heavier loading and possible off-road use, that passenger car tires receive when installed on a MPV, truck, bus or trailer instead of on a passenger car.

FMVSS No. 129, New non-pneumatic tires for passenger cars, includes definitions relevant to non-pneumatic tires and specifies performance requirements, testing procedures, and labeling requirements for these tires. To regulate performance, the standard contains performance requirements and tests related to physical dimensions, lateral strength, strength (in vertical loading), tire endurance, and high speed performance. The performance requirements and tests in FMVSS No. 129 were patterned after those in FMVSS No. 109.

The FMVSS No. 129 labeling requirements are similar to those set forth in section S4.3 of FMVSS No. 109 for size, designation, load, rating, rim size and type designation, manufacturer or brand name, certification, and tire identification number. The standard also includes temporary use and maximum speed labeling requirements and allows methods of permanent marking other than "molding" in anticipation of the difficulty of molding required information on non-pneumatic designs. FMVSS No. 129 became effective in August 1990.

D. Changes in U.S. Light Vehicle Market

Sales of light trucks (sport utility vehicles, vans and minivans, and pickup trucks) have increased steadily over the past 20 years and now account for almost half of the U.S. light vehicle market. While the number of passenger cars sold was 9.0 million units in 2000, the consumer preference for light truck vehicles continued to grow, reaching approximately 8.4 million units, just short of parity with passenger car sales. (Automotive News , 2001 Market Data Book).

Given the strong consumer demand for light trucks and that approximately 80% of these light trucks use passenger car (P-metric) tires, the net impact on original equipment passenger car tire shipments in 1999 reflects a record total of 61 million units, or a 6.8% growth over 1998's figure of 57.1 million units. Continued growth in the sales and production of light truck vehicles also drove the number of original equipment light truck (LT) tires to a record high of approximately 8.4 million units or a 25.2% increase over 1998's figures. (RMA 2000 Yearbook)

Given the increasing consumer preference for light truck use for passenger purposes, the agency believes that the tire standards being considered for passenger car tires should be extended to LT tires (up to load range E) used on light trucks. Load range E tires are typically used on SUVs and light trucks with a gross vehicle weight rating (GVWR) up to 10,000 pounds

E. Tire Harmonization

Work in UN/ECE's World Forum for Harmonization of Vehicle Regulations

On January 1999, the Rubber Manufacturers Association (RMA), along with five other petitioners, submitted a petition proposing that the agency begin rulemaking procedures to amend FMVSS No. 109 by adopting a new standard, Global Tire Standard 2000 for New

Pneumatic Car Tires (GTS-2000). According to the petitioners, the proposed GTS-2000 harmonized the best safety practices of various national standards. NHTSA granted this petition in June 1999. And in July 1999, NHTSA participated in the first of a series of working group meetings on global harmonization for passenger car tires with the Economic Commission for Europe (ECE), Working Party of Experts on Brakes and Running Gear (GRRF). The ECE/GRRF is responsible for developing safety regulations on brakes, tires, wheels, and other chassis components of motor vehicles.

The GTS-2000 proposal was used as a basis for initial discussions on harmonization and substitutes a single high-speed test for the four performance tests in FMVSS No. 109 for most radial tires.[1] More specifically, GTS-2000 was intended to replace the current FMVSS No. 109 high speed test with the high-speed test required by ECE-R30 (the European tire regulation for tires used on light passenger vehicles), including temporary spares, and limits the application of the other three tests currently required by FMVSS No. 109, namely the strength test, the bead unseating test, and the endurance test. RMA believes that these three tests have relevance to bias and bias-belted tires but little, if any, relevance to radial tires, with the single exception of the endurance test for low speed (160km/h/99 mph, or less) radial tires.

[1] As described by RMA, the proposed new global tire standard lists the following test criteria: (1) Physical dimensions for overall width and outer diameter; (2) strength test (plunger energy) for bias ply and bias-belted tires; (3) bead unseating resistance tests for bias-ply and bias-belted tires; (4) low speed (not less than 50 mph) endurance tests for bias-ply and bias belted tires plus all radial tires with a speed symbol of "Q" or below; and (5) high speed endurance tests for all tires (bias-ply, bias-belted, and radial). In addition, it contains labeling requirements covering tire pressure, load rating and tire construction.

II. PERFORMANCE REQUIREMENTS

Light Vehicle Tire Standard

The agency proposes that a new tire standard FMVSS No. 139 apply to tires used on passenger cars, multipurpose passenger vehicles, trucks, buses and trailers with a gross vehicle weight rating of 10,000 pounds or less. It would apply to all P-metric and LT tires up to load range E, and would not apply to motorcycles. The performance requirements of the current FMVSS Nos. 109 and 119; the proposed Global Tire Standard 2000 for New Pneumatic Car Tires (GTS 2000); and other proposed FMVSS No. 139 alternatives are discussed below:

A. High Speed Test Requirements

Current FMVSS No. 109 High Speed Test Requirement

The current FMVSS No. 109 high speed test presses the test tire assembly against the test wheel with a load of 88% of the tires maximum load rating as marked on the tire sidewall. The test tires are inflated as specified in Table II of FMVSS No. 109, which corresponds to a pressure that is 20 kPa or 3 psi less than the maximum pressure marked on the sidewall. The tire is run for 2 hours at 50 mph and allowed to cool to $100 \pm 5°$ F, followed by a readjustment of the inflation to the specified pressure. After the initial break in, the tire is tested at 75 mph for 30 minutes, 80 mph for 30 minutes, and 85 mph for 30 minutes. The tire is allowed to cool for one hour before deflating and dismounting it from the test wheel and inspecting for the failure criteria.

High Speed Test Alternatives

The agency considered three high speed alternative upgrade test scenarios. Alternative 1 considered adoption of the Global Tire Standard 2000 (GTS-2000) proposed by the tire industry. The GTS-2000 proposal attempted to create an internationally harmonized tire standard based on a tire's speed ratings using the same approach as ECE R 30, and the Society of Automotive Engineers (SAE) Recommended Practice J15161, *Laboratory Speed Test Procedure For Passenger Car Tires.* The agency reviewed GTS-2000 tire industry data and determined that alternative 1 was only slightly more stringent than the current FMVSS No. 109 high speed test. While taking this data into consideration , the agency developed alternative 3, a more stringent high speed test also based on the tires' speed rating. The agency conducted research tests based on tire speed ratings to determine an appropriate level of test performance criteria. When some of the high speed research test specifications in alternative 3 appeared to be overly stringent (based on a high percentage of tires failing these criteria), the agency developed alternative 2, which would provide a single minimum performance level for all tires that is more stringent than alternative 1, but less stringent than alternative 3.

GTS 2000 High Speed Endurance Test (Alternative 1)

The proposed GTS 2000 High Speed Endurance test uses a procedure similar to that of FMVSS No.109, except that the test speed and tire inflation are determined by the tire's speed rating. In GTS 2000 the test tire assembly is pressed against the test wheel with a load of 80% of the tire's maximum load rating as marked on the tire sidewall. The test tires are inflated as specified in Table II-1.

Table II-1 Inflation Pressure –kPa (psi)

Speed Category	Bias-ply Tires			Radial & Bias-Belted Tires	
	Ply Rating			Standard	Extra Load (Reinforced)
	4	6	8		
L, M, N	230 (33)	270 (39)	300 (44)	240 (34)	280 (40)
P, Q, R, S	250 (36)	300 (44)	330 (48)	260 (38)	300 (44)
T, U, H,	280 (40)	320 (46)	350 (50)	280 (40)	320 (46)
V	300 (44)	340 (49)	370 (53)	300 (44)	340 (49)
W, Y	-	-	-	320 (46)	360 (52)

* For inverted flange (CT) tires, increase test inflation pressure 50 kPa (7 psi)
* For T-type temporary spare tires, the tire shall be inflated to 420 kPa. (60psi)

The tire is tested without interruption as follows:

Accelerate at a constant rate such that an initial test speed of 40 km/h (25 mph) less than the speed rating is reached at the end of 10 minutes.

10 minutes at 40 km/h (25 mph) less than speed rating
10 minutes at 30 km/h (19 mph) less than speed rating
10 minutes at 20 km/h (12mph) less than speed rating
20 minutes at 10 km/h (6mph) less than speed rating
After the test, the tire is inspected for visible evidence of failure.
The tire speed ratings (L-ZR) are provided below in Table II-2

Table II-2
Speed Ratings

Speed Rating	Speed (km/h)	Speed (mph)
L	120	75
M	130	81
N	140	87
P	150	93
Q	160	99
R	170	106
S	180	112
T	190	118
U	200	124
H	210	130
V	240	150
W	270	169
Y	300	188
ZR	Over 240	Over 150

NHTSA Single Performance Level High Speed Tire Test (Alternative 2)

After reviewing the results of the Phase I and Phase II high speed tire tests (discussed later), the agency is proposing a single performance level 90 minute upgraded high speed tire test that will be conducted in three 30 minute steps without consideration of a tire's speed rating, at the speeds of 140, 150 and 160 km/h (88, 94, and 100 mph). The agency believes that this single performance level test represents a reasonable minimum capability that all tires operating on public roads should possess. The tests are to be conducted at 85% of the maximum sidewall load at an inflation pressure of 220 kPa (32 psi) for standard load P-metric tires. Light truck (LT) tires will be tested at inflation pressures of: 320 kPa (46 psi) for load range C tires; 410 kPa (60 psi) for load range D tires; and 500 kPa (73 psi) for load range E tires. The proposed Alternative 2 high speed test requirement is more stringent than the current FMVSS No. 109, and Alternative 1 (GTS-2000) requirements, but less stringent than Alternative 3.

NHTSA Speed Rated High Speed Tire Test (Alternative 3)

The agency developed alternative 3, a speed rated high speed tire test similar to but more strigent than the GTS-2000 high speed tire tests. The tests were run by accelerating the test tire up to the initial test speed (ITS) for ten minutes, and then continuously without stopping, testing the tire at the four speeds (ITS, ITS + 10km/h, ITS + 20 km/h, and ITS + 30km/h) for twenty minutes at each step. Thus, the 20 minute step duration high speed tire test would require 90 minutes to complete (10 minutes up to ITS and four 20 minute speed steps = 90 minutes).

The ITS is 30 km/h less than the speed rating of the tire. Non-speed rated tires are tested at the same speed as "Q" rated tires. Tires rated above "H" are tested at the same speed as "H" rated tires. P-metric tires are to be tested at 220 kPa inflation pressure, which represents an under-inflation pressure of about 8 percent from the maximum inflation pressure of 240 kPa. LT tires are to be held to a similar level of under-inflation. Thus, for the high speed tire test, the tire inflation pressures for load range C, D, and E are 320, 420 and 550 kPa respectively.

TABLE II-3

HIGH SPEED TEST COMPARISON

TEST PARAMETERS	**FMVSS 109**	**GTS-2000** **Alternative 1**	**NHTSA Single Performance Level Alternative 2**	**NHTSA Speed Rated** **Alternative 3**
Ambient (°C)	38	25	40	40
Load (%)	88	80	85	85
Inflation Pressure (kPa) P-metric Standard/Extra Load LT load range C/D/E Speed Rating (Standard/Extra) L,M,N P,Q,R,S T,U,H V W,Y	 220/260 - - - - - -	 240/280 260/300 280/320 300/340 320/360	 220/260 320/410/550	 220/260 320/410/550
Test Speed* (km/h) ITS = L,M,N,P,Q R,S,T,U, H,V,W,Y	121/129/13 7	ITS, +10, +20, +30 90,100,110,120,130 140,150,160,170 180,210,240,270	140/150/160	ITS, +10, +20, +30 140 140,150,160,170 180
Duration (mins)	90	50	90	90

NHTSA High Speed Tire Test Results

The agency conducted two series of high speed and endurance tire tests. In Phase I the agency tested one each of the 9 P-metric and 3 LT tire models listed below in Table II-4. In Phase II the agency tested five each of the 8 P-metric and 4 LT tire models which are listed in Table II-7. The "S" in the P-metric tire load range, means standard duty. The LT tires may be marked with a UTQGS grade, but this is not required of LT tires.

Table II-4
Phase I Tires

Brand	Model	Size	LR	SR	PSI	UTQG Wear	UTQG Traction	UTQG Temp
P-Metric Tires								
Bridgestone	Potenza RE92	P205/65R15	S	H	44	160	A	A
Futura	2000 Radial ATD	P205/75R14	S	S	35	440	A	B
Dunlop	D65 Touring	P205/70R14	S	T	35	600	A	B
Firestone	Wilderness AT	P255/70R16	S	S	44	440	B	C
Firestone	Radial ATX	P235/75R15	S	S	35	None	None	None
Hankook	Optimo Plus II	P205/65R15	S	H	35	320	A	A
Michelin	Energy MXV4 Plus	205/65R15	S	H	44	400	A	A
National	XT 5000	P225/60R16	S	S	35	560	A	B
Pirelli	P4000	P205/60R15	S	H	44	320	A	A
Light Truck Tires								
Goodyear	Wrangler AT/S	LT235/75R15	C	N/A	50	None	None	None
Michelin	XPC 4x4	235/70R16	C	H	51	440	A	B
Yokohama	GeoLandar H/T	LT225/75R16	D	S	65	None	None	None

LR = Load Range; SR = Speed Rating

In Phase I, the agency ran 243 P-metric tire and 81 LT tire high speed tests including all combinations of 10, 20, and 30 minute test step duration; 180, 210, and 240 kPa inflation pressures for P-metric tires, 260/340, 300/390, and 350/450 kPa for the C&D Load range LT tires; and loads of 80, 90 and 100%. The tests were run by accelerating the test tire up to the initial test speed (ITS) by the end of ten minutes, and then continuously without interruption, testing the tire at the four speeds (ITS, ITS + 10km/h, ITS + 20 km/h, and ITS + 30km/h) for the time duration of each step. Thus, the 10 minute step duration tests require 50 minutes to complete (10 minutes up to ITS and four 10 minute speed steps = 50 minutes): the 20 minute step duration requires 90 minutes to complete (10 minutes up to ITS and four 20 minute speed steps = 90 minutes); and the 30 minute step duration requires 130 minutes to complete (10 minutes up to ITS and four 30 minute speed steps = 130 minutes). The ITS is 30 km/h less than the speed rating of the tire. Non-speed rated tires are tested at the same speed as "Q" rated tires. Tires rated above "H" are tested at the same speed as "H" rated tires. All the tires that were inflated to 180 kPa and 240 kPa tires were tested to failure, and the 210 kPa tires were only tested to completion, unless they failed the test. A summary of the 243 high speed P-metric tire test's time to failure is presented in the Table II-5 below, segregated by the tire's UTQGS Temperature rating:

Table II-5
Phase I P-Metric Tire Test Results Summary
50 Minute High Speed Tire Test (10 min step duration)

	UTQG Temp	180 kPa		210 kPa		240 kPa	
		Failure Ave Time	Failures	Failure Ave Time	Failures	Failure Ave Time	Failures
80% Load	A	60 minutes	0/4	50 minutes	0/4	79minutes	0/4
80% Load	B	76 minutes	0/3	50 minutes	0/3	82 minutes	0/3
80% Load	C	48 minutes	2/2	50 minutes	0/2	59 minutes	0/2
90% Load	A	54 minutes	2/4	44 minutes	2/4	60 minutes	0/4
90% Load	B	56 minutes	0/3	50 minutes	0/3	71 minutes	0/3
90% Load	C	56 minutes	1/2	50 minutes	0/2	71 minutes	0/2
100% Load	A	48 minutes	2/4	44 minutes	2/4	60 minutes	1/4
100% Load	B	52 minutes	1/3	50 minutes	1/3	71 minutes	0/3
100% Load	C	44 minutes	2/2	47 minutes	2/2	51 minutes	2/2

90 Minute High Speed Tire Test (20 min step duration)

	UTQG Temp	180 kPa		210 kPa		240 kPa	
		Failure Ave Time	Failures	Failure Ave Time	Failures	Failure Ave Time	Failures
80% Load	A	96 minutes	1/4	87 minutes	1/4	108 minutes	0/4
80% Load	B	107 minutes	0/3	90 minutes	0/3	122 minutes	0/3
80% Load	C	65 minutes	2/2	87 minutes	1/2	100 minutes	0/2
90% Load	A	87 minutes	2/4	77 minutes	2/4	99 minutes	1/4
90% Load	B	86 minutes	1/3	61 minutes	1/3	106 minutes	1/3
90% Load	C	77 minutes	2/2	88 minutes	2/2	60 minutes	2/2
100% Load	A	69 minutes	3/4	91 minutes	1/4	98 minutes	2/4
100% Load	B	82 minutes	3/3	84 minutes	1/3	94 minutes	1/3
100% Load	C	51 minutes	2/2	75 minutes	2/2	80 minutes	2/2

130 Minute High Speed Tire Test (30 min step duration)

	UTQG Temp	180 kPa		210 kPa		240 kPa	
		Failure Ave Time	Failures	Failure Ave Time	Failures	Failure Ave Time	Failures
80% Load	A	114 minutes	2/4	124 minutes	1/4	125 minutes	1/4
80% Load	B	130 minutes	0/3	130 minutes	0/3	130 minutes	0/3
80% Load	C	104 minutes	2/2	113 minutes	2/2	122 minutes	2/2
90% Load	A	117 minutes	2/4	120 minutes	2/4	124 minutes	1/4
90% Load	B	105 minutes	2/3	125 minutes	1/3	130 minutes	0/3
90% Load	C	104 minutes	2/2	102 minutes	2/2	113 minutes	2/2
100% Load	A	104 minutes	3/4	117 minutes	3/4	120 minutes	2/4
100% Load	B	101 minutes	3/3	114 minutes	2/3	129 minutes	1/3
100% Load	C	93 minutes	2/2	115 minutes	1/2	105 minutes	2/2

When the data in the three P-metric tire tables are examined, it is apparent that the number of failures increased as: the test speed increased; the length of the test increased; the load increased; and the inflation pressure decreased. As the test severity increased, the C temperature graded tires failed with greater frequency than the B or A temperature graded tires. For the two groups of tires run to their ultimate failure, the average time to failure for each of the temperature grades were: A = 60 minutes; B = 68 minutes; and C = 49 minutes.

The agency usually expects C tires to fail earlier than B tires in the high speed test, and the B tires to fail earlier than the A tires. While both the A and B tires out lasted the C tires, the agency believes the A tires failing before the B tires is an anomaly due to the particular tires in the small sample. Two of the four A tires performed poorly. The Pirelli P4000 tires were 4 years old, thus the aging affect may have caused them to fail earlier. The Hankook Optimo Plus II tires performed poorly for an A grade tire. These two tires significantly pulled the overall average of the A graded tires down.

A summary of the 81 high speed LT tire tests is presented in the Table II-6 below: LT tires are not required to have UTQGS grades, thus they do not have the comparative temperature ratings that were marked on the P-metric tires.

Table II-6
Phase I LT Tire Test Results Summary
50 Minute High Speed Tire Test (10 min step duration)

	C – 260 / D - 310 kPa		C – 300 / D - 390 kPa		C – 350 / D - 450 kPa	
	Failure Ave Time	Failures	Failure Ave Time	Failures	Failure Ave Time	Failures
80% Load	62 minutes	0/3	50 minutes 3tcnf*	0/3	72minutes	0/3
90% Load	58 minutes	0/3	50 minutes 3tcnf	0/3	66 minutes	0/3
100% Load	57 minutes	0/3	50 minutes 3tcnf	0/3	66 minutes	0/3

90 Minute High Speed Tire Test (20 min step duration)

	C – 260 / D - 310 kPa		C – 300 / D - 390 kPa		C – 350 / D - 450 kPa	
	Failure Ave Time	Failures	Failure Ave Time	Failures	Failure Ave Time	Failures
80% Load	103 minutes	1/3	89 minutes 2tcnf	1/3	127 minutes	0/3
90% Load	115 minutes	0/3	87 minutes 2tcnf	1/3	124 minutes	0/3
100% Load	82 minutes	2/3	91 minutes	2/3	98 minutes	1/3

130 Minute High Speed Tire Test (30 min step duration)

	C – 260 / D - 310 kPa		C – 300 / D - 390 kPa		C – 350 / D - 450 kPa	
	Failure Ave Time	Failures	Failure Ave Time	Failures	Failure Ave Time	Failures
80% Load	125 minutes 2tcnf	1/3	128 minutes 2tcnf	1/3	130 minutes 3tcnf	0/3
90% Load	119 minutes 2tcnf	0/3	126 minutes 2tcnf	1/3	115 minutes 1tcnf	2/3
100% Load	97 minutes 1tcnf	2/3	121 minutes 1tcnf	1/3	128 minutes 2tcnf	2/3

* tcnf – test complete no failure

When the data in the three LT tire tables are examined, it is apparent that the number of failures increased as: the test speed increased; the length of the test increased: the load increased; and the inflation pressure decreased. These were the same trends exhibited by the P-metric passenger car tires.

An additional 280 P-metric and 140 LT high speed tire tests were conducted by the agency in Phase II testing, which consisted of a series of 4 different high speed tests with 5 tires of each model tested. The 8 P-metric and 4 LT tire models tested in Phase II are listed below:

Table II-7
Phase II Tires

PHASE II Brand	Model	Size	LR	SR	PSI	UTQG Wear	UTQG Traction	UTQG Temp
P-Metric Tires								
Toyo	Proxes H4	P225/60R16	S	H	44	400	A	A
Uniroyal	Tiger Paw Touring HR	P225/60R16	S	H	44	400	A	A
Dunlop	D65 Touring	P205/65R15	S	T	35	560	A	B
Goodyear	Regatta 2	P205/65R15	S	T	44	560	A	B
BF Goodrich	Cientra Plus	P235/75R15	S	S	35	560	A	B
Cooper	LifeLiner Classic II	P235/75R15	S	S	35	560	A	B
Firestone	Wilderness AT	P235/75R15	S	S	35	440	A	C
Michelin	XH4	P235/75R15	S	S	35	580	A	B
Light Truck Tires								
Pirelli	Scorpion P/T	LT235/75R16	C	S	50	None	None	None
Yokohama	GeoLandar A/T	LT235/75R15	C	S	50	None	None	None
Goodyear	Wrangler HT	LT245/75R16	E	R	80	None	None	None
Bridgestone	R273 SWP 11	LT245/75R16	E	Q	80	None	None	None

LR = Load Range; SR = Speed Rating

Table II-8 Phase II High Speed Test Results Summary

Brand	Model	UTQGS Temp Grade	High Speed Test1	High Speed Test 2	High Speed Test 3	High Speed Test 4
P-Metric Tires						
Toyo	Proxes H4	A	4P* 1F#	5P 0F	5P 0F	5P 0F
Uniroyal	Tiger Paw Touring HR	A	5P 0F	5P 0F	5P 0F	5P 0F
Dunlop	D65 Touring	B	5P 0F	5P 0F	5P 0F	5P 0F
Goodyear	Regatta 2	B	0P 5F	0P 5F	1P 4F	0P 5F
BF Goodrich	Cientra Plus	B	0P 5F	0P 5F	0P 5F	2P 3F
Cooper	LifeLiner Classic II	B	3P 2F	4P 1F	5P 0F	5P 0F
Firestone	Wilderness AT	C	1P 4F	0P 5F	0P 5F	4P 1F
Michelin	XH4	B	0P 5F	0P 5F	0P 5F	5P 0F

LT Tires		Load Range	High Speed Test1	High Speed Test1	High Speed Test1	High Speed Test1
Pirelli	Scorpion A/T	C	5P 0F	5P 0F	5P 0F	5P 0F
Yokohama	GeoLandar H/T	C	5P 0F	5P 0F	5P 0F	4P 1F
Goodyear	Wrangler HT	E	5P 0F	5P 0F	5P 0F	5P 0F
Bridgestone	R273 SWP 11	E	5P 0F	5P 0F	5P 0F	5P 0F

* P - Pass, # F – Failure

Phase II Test Conditions

High Speed Test 1 – 80% Load; ITS + 30 km/h (19 mph); 20 minute duration;
P-metric tires - 210 kPa (30 psi),
LT tires Load Range C – 310 kPa (44psi), Load Range E – 530 kPa (77 psi)
High Speed Test 2 – 80% Load; ITS + 30 km/h (19 mph); 20 minute duration;
P-metric tires 220 kPa (32 psi)
LT tires Load Range C – 320 kPa (46 psi), Load Range E – 550 kPa (80 psi)
High Speed Test 3 – 80% Load; 160/170/180 km/h (99/106/112 mph), 30 minute duration;
P-metric tires 210 kPa(30 psi)
LT tires Load Range C – 310 kPa (44psi), Load Range E – 530 kPa (77 psi)
High Speed Test 4 – 85% Load; ITS + 30 km/h (19 mph); 20 minute duration;
P-metric tires 220kPa (32 psi)
LT tires Load Range C – 330 kPa (48psi), Load Range E – 560 kPa (81psi)

In the Phase II tests, all of the A Temperature grade tires except one completed their tests without a failure. Two B tire models performed as well as the A tire models, while three B tire models performed as poorly as the one C tire model. All of the LT tires tested except one completed the tests without failure.

Note that in eight cases there were discrepancies in the pass/fail outcomes of the tests for the five tires (e.g., 4 passed and 1 failed or 2 passed and 3 failed). This led the agency to examine the manufacture quality control of the tires themselves. (See discussion later in this chapter.)

High Speed Tire Test Alternatives Analysis

The agency reviewed the Phase I and Phase II test data, and examined the percentage of tires that would pass each of the alternatives. Table II-9 presents the percentages of tires tested that would pass each of the alternative tests.

Table II-9
Percent of Tires That Passed the High Speed Alternative Tests

	Phase I Tests			Phase II Tests		
	Alternative 1	Alternative 2	Alternative 3	Alternative 1	Alternative 2	Alternative 3
P-metric tire % passed	100	100	67	100	100	63
LT tires % passed	NA	67	67	NA	100	75

The percentages in Table II-9 verifies that the vast majority of tires tested can pass alternative 2 minimum performance criteria. The agency believes the selected speed levels in alternative 2 establishes a reasonable minimum performance requirement that is appropriate for safety standards of motor vehicle equipment. All the tires easily passed the alternative 1 criteria, which proved this alternative did not distinguish different tire performance levels. The agency believes alternative 3 is too stringent because it is based on a tires speed rating. Tires with higher speed ratings can fail because they are tested beyond a minimum capability necessary for safe operation. The only tires that failed alternative 3, were those tested well beyond the interstate speed limits and the capability of many vehicles sold in the U.S.

B. Endurance Test Requirements

Current FMVSS No. 109 Endurance Test Requirement

The current endurance test in FMVSS No. 109 is conducted at 80 km/h (50 mph) for a total of 34 hours at loads of: 85% for 4 hours, 90% for 6 hours, and 100% for 24 hours of the maximum rated tire load, at an inflation pressure of 180 kPa (26 psi). The total distance for the current endurance test is 2720 km (1700 miles). The 50 mph test speed may have been an appropriate speed in 1968 when the standard was initially proposed for bias ply tires, but the agency believes that speed to be too low for evaluating the endurance of today's tires, given current vehicle performance capabilities and vehicle traffic speeds.

Current FMVSS No. 119 Endurance Test Requirement

The current endurance test in FMVSS No. 119 for LT tires is similar to FMVSS No. 109. The current endurance test requirements for FMVSS No. 119 is a 47-hour duration test run at the maximum inflation pressure on the tire label, at 80 km/h (50 mph) for Load Range A, B, C, and D tires at: 75% of the rated load for 7 hours, 97% of the rated load for 16 hours, and 114% of the rated load for 24 hours, and at 64 km/h (40 mph) for Load Range E tires at: 70% of the rated load for 7 hours, 88% of the rated load for 16 hours, and 106% of the rated load for 24 hours.

GTS 2000 Endurance Test

In GTS 2000, the tire industry proposed a global harmonized endurance test for passenger car radial tires rated Q and below. The test parameters included a load of 100/110/115% at a speed of 80 km/h (50 mph), for 34 hours duration at an inflation pressure of 180 kPa (26 psi). Agency testing indicates that all presently manufactured P-metric tires can pass the industry's proposed test with no failures.

Endurance Test Alternatives

The agency considered three alternative endurance upgrade test scenarios. Alternative 1 considered adoption of a protocol proposed by the Rubber Manufacturer's Association (RMA). This protocol (RMA 2000) is similar to the GTS-2000 endurance test for tires rated Q or less, with the main difference being the test speed was increased from 80 km/h to 120 km/h. The agency reviewed RMA 2000 endurance test data submitted by the tire industry and observed that all the tires passed the test. Taking this data into consideration, the agency conducted research tests to develop a more stringent set of performance criteria, alternative 3. When the endurance research test specifications in alternative 3 appeared to be overly stringent, the agency developed alternative 2, which is more stringent than alternative 1, but less stringent than alternative 3.

RMA 2000 Test Protocol (Alternative 1)

In December 2000, the RMA presented to NHTSA a test protocol, RMA 2000, that was designed and administered with the tire industry. The test protocol included the following principal parts: passenger car and light truck tire high speed tests, passenger car and light truck tire endurance tests. RMA 2000's recommended endurance test parameters are listed below:

Passenger tires – Inflation pressure - 180 kPa; Test speed - 120 km/h; Duration – 8 hours at 85% of max rated load, 8 hours at 90% of max rated load, and 8 hours at 100% of max rated load; Ambient temperature – 38°C +/- 3°C

LT tires - Inflation pressure – maximum load marked on tire sidewall; Test speed - 120 km/h; Duration – (Load Range A-D) 8 hours at 75% of max rated load, 8 hours at 97% of max rated load, and 8 hours at 114% of max rated load; (Load Range E) 8 hours at 70% of max rated load, 8 hours at 88% of max rated load, and 8 hours at 106% of max rated load; Ambient temperature – 38°C +/- 3°C

NHTSA Initial Research Endurance Test Parameters (Alternative 3)

Using data from RMA 2000 the agency developed an initial set of endurance test parameters listed below to test the endurance of current market tires:

Ambient temperature – ≥40°C

Test speed - 120 km/h;

Duration 8 hrs @ 100% of max load
10 hrs @ 110% of max load
32 hrs @ 115% of max load

P-metric tire inflation pressure – 180 kPa
LT tire inflation pressure – Load Range C/D/E 260/340/450 kPa

NHTSA Proposed Endurance Test Parameters (Alternative 2)

After the agency determined that the initial research parameters (alternative 3) may be too stringent the agency developed the alternative 2 test parameters which are less stringent than alternative 3 but more stringent than alternative 1. The main difference between alternatives 2 and 3 is that the tire loads are lighter, the duration is 10 hours shorter, and the LT tire inflations are higher. The NHTSA proposed endurance test parameters for alternative 2 are as follows:

Ambient temperature – ≥40°C

Test speed - 120 km/h;

Duration 8 hrs @ 90% of max load
10 hrs @ 100% of max load
22 hrs @ 110% of max load

P-metric tire inflation pressure – 180/220 kPa Standard/Extra Load
LT tire inflation pressure – Load Range C/D/E 320/410/550 kPa

TABLE II-10

ENDURANCE TEST COMPARISON

TEST PARAMETERS	**FMVSS 109**	**FMVSS 119**	**RMA-2000 Alternative 1**	**NHTSA Proposal Alternative 2**	**NHTSA Initial Research Alternative 3**
Ambient (°C)	38	38	38	40	40
Load (%)					
P-metric	85/90/100	-	85/90/100	90/100/110	100/110/115
LT load range C/D	-	75/97/114-	75/97/114	90/100/110	100/110/115
LT load range E		66/84/101	70/88/106	90/100/110	100/110/115
Inflation Pressure (kPa)					
P-metric					
Standard/Extra Load	180/220		180	180/220	180
LT load range C/D	-	sidewall max	sidewall max	320/410	260/340
LT load range E		sidewall max	sidewall max	550	450
Test Speed (km/h)	80	80	120	120	120
Duration (hours)	34	34	24	40	50

NHTSA Endurance Test Results

Phase I endurance testing was conducted on the same P-metric tires listed in the previous High Speed Test Requirement section, at 120 km/h (75 mph) and 140 km/h (87 mph), with loads of 100%, 115%, and 125% of the maximum rated load for a total of 50 hours, and at inflation pressures of 160 kPa (23 psi) and 200 kPa (29 psi). At speeds of 120 km/h (75 mph) and 140 km/h (87 mph), the total test distance is 6000 km (3,728 miles) and 7,000 km (4,350 miles), respectively, which is more than twice the distance of the current passenger car tire endurance test. The LT tires previously listed in the high speed tests were also endurance tested at the same speeds for 50 hours with the same percentages of the maximum rated loads. The LT tires were inflated to 75% of their respective maximum inflation pressures. The results of these Phase I endurance tests are summarized below in Table II-11.

Table II-11
50 Hour P-Metric Tire Endurance Test

Speed	UTQG Temp	160 kPa (23psi)		200 kPa (29 psi)	
		Ave Time to Failure	Pass/Fail	Ave Time to failure	Pass/Fail
120km/h (75 mph)	A	50 hours	4P 0F	50 hours	4P 0F
120km/h (75 mph)	B	38 hours	1P 2F	43 hours	2P 1F
120km/h (75 mph)	C	19 hours	0P 2F	35 hours	1P F
140km/h (87 mph)	A	42 hours	3P 1F	50 hours	4P 0F
140km/h (87 mph)	B	12 hours	0P 3F	25 hours	0P 3F
140km/h (87 mph)	C	17 hours	0P 2F	8 hours	0P 2F

50 Hour LT Tire Endurance Test

Speed	Load Range	C – 240 kPa (35 psi) D - 300 kPa (44 psi)		C – 290 kPa (42 psi) D - 380 kPa (55 psi)	
		Ave Time to Failure	Pass/Fail	Ave Time to Failure	Pass/Fail
120km/h (75 mph)	C	36 hours	1P 1F	48 hours	1P 1F
120km/h (75 mph)	D	32 hours	0P 1F	35 hours	0P 1F
140km/h (87 mph)	C	15 hours	0P 2F	13 hours	0P 2F
140km/h (87 mph)	D	20 hours	0P 1F	37 hours	0P 1F

Many of the P-metric tire failures occurred at the combination of low inflation pressure 160 kPa (23 psi) and speed of 140 km/h (87 mph). At a test speed of 120 km/h (75 mph) with an inflation pressure of 200 kPa (29 psi), 2 of the 9 P-metric tires (one B and one C Temperature rated) failed to complete the 50-hour test. Examination of the data in the P-metric Tire and LT Tire tables shows that the number of failures increased and time to failure decreased as: the test speed increased; and the inflation pressure decreased. Also in the P-metric table, the A temperatue rated tires performed better than the B rated tires, which performed better than the C rated tires.

In Phase II Endurance Test 2, the agency tested tires with loading conditions of 100/110/115%, which are identical to the loads recommended by the tire industry for the endurance test in GTS-2000, at 180 kPa (26 psi) inflation pressure and 120 km/h (75 mph) for 50 hours. This combination of parameters for P-metric tires represents a 50 percent increase in the speed, a 50 percent increase in the duration, and up to a 15 percent increase in the load, which constitutes a more stringent test than the current endurance test in FMVSS No. 109. In Endurance Tests 1 and 3, the test loads were 100/115/125% and the test speed was 100 km/h (62 mph).

The LT tires were tested to the same parameters as the P-metric tires, except that the inflation pressures were 25 percent under-inflated from the maximum inflation pressure for load range C and D tires. Therefore, the test inflation pressures proposed for LT load range C and D tires subjected to the endurance test are 260 kPa (38 psi) and 340 kPa (50 psi), respectively. The load range E tires were tested at 450 kPa (65psi).

In the Phase II Endurance tests of P-metric tires, 2 (A temperature rated) tire models of the 8 tires models completed the tests without any failures in their 5 samples. The remaining tire B and C rated models experienced at least one failure in the five samples used during the test. Most of the LT tire models had one of the five tires fail a test. The most notable exception was the Bridgestone R 273 which had all five tires fail Endurance Test 3.

NHTSA Proposed Endurance Phase II Testing

The proposed alternative 2 endurance test requirement is more stringent than the current FMVSS Nos. 109 and 119 requirements. But these proposed conditions are not the same as those tested in the Phase I (Table II-11) or Phase II (Table II-12). The agency believes that this lower than tested stringency represents a reasonable minimum capability that all tires operating on public

Table II-12
Phase II Endurance Test Summary

Brand	Model	UTQGS Temp Grade	Endurance Test 1	Endurance Test 2	Endurance Test 3
P-Metric Tires					
Toyo	Proxes H4	A	5P* 0F#	5P 0F	5P 0F
Uniroyal	Tiger Paw Touring HR	A	5P 0F	5P 0F	5P 0F
Dunlop	D65 Touring	B	5P 0F	3P 2F	5P 0F
Goodyear	Regatta 2	B	5P 0F	1P 4F	0P 5F
BF Goodrich	Cientra Plus	B	5P 0F	3P 2F	4P 1F
Cooper	LifeLiner Classic II	B	1P 4F	2P 3F	1P 4F
Firestone	Wilderness AT	C	5P 0F	3P 2F	1P 4F
Michelin	XH4				
LT Tires					
Brand	**Model**	**Load Range**	**Endurance Test 1**	**Endurance Test 2**	**Endurance Test 3**
Pirelli	Scorpion A/T	C	5P 0F	4P 1F	4P 1F
Yokohama	GeoLandar H/T	C	4P 1F	4P 1F	5P 0F
Goodyear	Wrangler HT	E	4P 1F	4P 1F	4P 1F
Bridgestone	R273 SWP 11	E	4P 1F	4P 1F	0P 5F

* P - Pass, # F - Failure

Phase II Test Conditions

Endurance Test 1 – 100/115/125% Load, 100 km/h, P-metric 180 kPa (26 psi), LT 75% of Max Inflation

Endurance Test 2 – 100/110/115% Load, 120 km/h, P-metric 180 kPa (26 psi), LT 75% of Max Inflation

Endurance Test 3 – 100/115/125% Load, 120 km/h, P-metric 180 kPa (26 psi), LT 75% of Max Inflation roads should possess. The selected inflation pressure is also set at a level well above the warning criteria of the Tire Pressure Monitoring System (TPMS). In actual use, the agency would expect properly inflated and not overloaded tires that "pass" the endurance test to be capable of withstanding sustained use at 75 mph for more than 40 hours, since this a legal interstate speed limit in nearly all states.

Endurance Tire Test Alternatives Analysis

The agency reviewed the Phase I and Phase II test data, and estimated the percentage of tires that would pass each of the alternatives. Table II-13 presents the percentages of tires tested that would pass each of the alternative tests.

Table II-13
Percent of Tires That Passed the Endurance Alternative Tests

	Phase I Tests			Phase II Tests		
	Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 1**	**Alternative 2**	**Alternative 3**
P-metric tire % passed	100	89	56	100	75	25
LT tires % passed	100	100	33	100	75	-0-

All the tires easily passed the alternative 1, the RMA 2000 endurance test, which proved this alternative did not distinguish different tire performance levels. Conversely, very few tires passed alternative 3. The initial NHTSA research test parameters were deemed to be too stringent. The agency believes alternative 2 establishes a reasonable minimum performance requirement that is appropriate for safety standards of motor vehicle equipment.

C. Low Pressure – Endurance Test / Low Pressure - High Speed Test

Currently, there are no high speed, low pressure test requirements or low pressure, endurance test requirements in the existing FMVSS Nos. 109 &119. NHTSA conducted two tests to evaluate tire performance at the low inflation threshold level being proposed for Tire Pressure Monitoring Systems (TPMS) for light vehicles.

The TREAD Act requires that light vehicles be equipped with a TPMS, effective November 1, 2003, to indicate to the driver when any of the tires are significantly under-inflated. When vehicles are equipped with a TPMS, the agency believes that some drivers may be less likely to check their tire pressures until the warning lamp is illuminated. As a result, the agency proposed, in the TPMS rulemaking, to establish a low pressure threshold at which the low pressure warning light must be activated. The agency believes that the new upgraded tire standard should include a linkage with the proposed requirements of the TPMS standard. The TPMS standard would allow each vehicle manufacturer to establish the level of under-inflation [The agency proposed two alternatives of 80%–75% of the recommended cold inflation pressure with a minimum of 140 kPa (20 psi)] at which the low inflation pressure warning lamp would be illuminated.

Low Pressure Endurance Test (Alternative 1)

This test is predicated upon the notion that a low pressure test would be most appropriate on tires that have completed the endurance test because a significantly underinflated condition for a tire is more likely to occur in a tire after several weeks of natural air pressure loss or due to a slow leak. The agency conducted 90 minute low pressure endurance test at 140 kPa (20 psi) inflation pressure, at a speed of 120 km/h (75 mph) and 100% load on the tires (2 samples of each of the 12 brands) that passed the endurance test. Similar tests were performed using the LT tires at 58 percent of their maximum sidewall inflation pressure. These low threshold values were selected based on the lowest inflation pressure at which a tire load is provided by the tire industry standardizing bodies. The results indicate that all 24 tires tested completed the test without failure.

This test provides an extra safeguard to ensure that tires which were able to successfully complete the endurance testing can also complete an additional 90 minute test at low inflation pressure. The agency believes that this test would establish some minimum safeguard for low inflation pressure operation for a short duration. Thus, when a driver receives the TPMS warning, there is still time for him/her to take corrective action before the tire fails, assuming that the tire is not experiencing a very rapid loss of pressure.

Low Pressure High Speed Test (Alternative 2)

This proposed test provides a linkage between the proposed TPMS requirements and the proposed high speed test. While it would evaluate tires at a lower load than that specified in the Low Pressure Endurance test, the Low Pressure High Speed test would ensure that a manufacturer designs a tire so that its high speed performance would comply with the test requirements not only at recommended inflation pressure, but also at a low inflation pressure.

The 90 minute Low Pressure High Speed Test is conducted in three 30 minute speed steps of 140, 150, and 160 km/h (87, 93, and 99 mph) at 67% load and 140 kPa (20 psi) inflation pressure. A tire is considered to have passed the test if it completes the 30-minute step at 160 km/h (100 mph). NHTSA recently conducted testing of the above parameters on 8 tire brands. The results indicate that 30 percent of tires with an "S" speed rating, 63 percent of tires with an "R" speed rating, and 75 percent of tires with a "Q" speed rating would not pass this test. However, 70 percent of tires with an "S" speed rating, and all "T" and "H" rated tires would have completed the test. The agency estimates that about 30 percent of all light vehicle tires currently on the market would fail this test.

The agency believes that this test would ensure that the tire manufacturer designs a tire so that its high speed performance would comply with high speed requirements at both the recommended inflation pressure and also at a low inflation pressure.

D. Road Hazard Impact Test Requirements

Both FMVSS No 109 & 119 have a tire strength requirement, which states, "each tire will have a minimum breaking energy." The test is conducted by forcing a 19mm ($^3/_4$ inch) diameter cylindrical steel plunger with a hemispherical end perpendicularly into the tread. The breaking energy is determined by means of the following formula: W = [(FxP)/2] where W=Energy, F=Force, and P=Penetration. This test was relevant thirty years ago when the standard was issued, and all tires were bias ply. With practically all tires being radials now, it is essentially a non-test because the plunger bottoms out on the rim before penetration occurs.

The agency is proposing to update the strength test by adopting the SAE J1981, Road Hazard Impact Test, as a substitute for the strength (plunger) test. The SAE J1981 test is a dynamic procedure that uses a pendulum to strike the tire. The proposed minimum performance requirements are based on the current strength test values in FMVSS Nos. 109 and 119. For standard load P-metric tires, the proposed breaking energy, W is 294 joules (2600 inch-pounds) for tires with a width of 160 mm or greater, and 220 joules (1950 inch-pounds) for tires with a width less than 160 mm.

The proposed breaking energy values for LT tires are derived from the current requirements in FMVSS No. 119 and are as follows: 362 joules (3200 inch-pounds) for load range C tires; 515 joules (4550 inch-pounds) for load range D tires; and 577 joules (5100 inch-pounds) for load range E tires.

The agency is conducting tests on a sample of tires to determine the suitability of the test and current compliance with this test. These tests have not been completed yet.

E. Bead Unseating Test Requirements

The current resistance-to-bead unseating test is designed to evaluate how well the tire bead remains on the rim during turning maneuvers. The bead unseating test forces currently used in FMVSS No. 109 are based on bias ply tires and are typically not stringent enough for radial tires. For this reason, the industry, in GTS-2000, recommended that the test be deleted from the standard because radial tires are able to satisfy the test easily. Results from the agency's 1997-1998 dynamic rollover testing, however, provide a strong rationale for seeking to replace, rather than delete, the bead unseating requirement in FMVSS No. 109. In this testing, vehicles experienced bead unseating on three of twelve test vehicles. This bead unseating occurred during severe maneuvers. Such bead unseating in the real world poses serious safety concerns. Therefore, NHTSA proposes to replace the current bead unseating test in FMVSS No. 109 with a more stringent and appropriate test developed by Toyota, called the Toyota Air Loss Test.

The Toyota Air Loss Test was developed by Toyota to evaluate tubeless tire performance. While the current FMVSS No. 109 bead unseating test applies force in the middle of the sidewall, the Toyota Air Loss Test applies force at the tire tread surface edge. The tire tread surface edge is the actual location at which force occurs due to tire/road interface during severe vehicle maneuvers. There are two general methods for conducting the Toyota test:

1. Air Loss Bench Test Method: A tire that receives a lateral force from the ground is deformed and may be deflated as its tire bead is separated from the rim bead. The air loss test is intended to measure the tire inflation pressure at which a tire is deflated under the above condition. The test may be conducted with an actual vehicle or with a tire assembly on a test bench.
2. On-Vehicle Air Loss Test Method: When an actual vehicle is used for the air loss test, the vehicle is driven at 60 km/h along a straight course, then makes a curve with a radius of 25 meters, so that a lateral force is applied to the tire. This so-called J-turn test method is recommended because the fluctuation in input load is relatively small.

NHTSA proposes to adopt the Air Loss Bench Test Method because the test is independent of vehicle type, although the agency seeks comments on both methods. This test method uses a force of 2.1 times the maximum tire load labeled on the sidewall, which is applied at the tread surface. The wedge-shaped device applies a force on the tire, laterally, at the tread surface. This force simulates the lateral force at the tread surface, which a tire experiences during severe maneuvers that could produce bead unseating of the tire.

Toyota has provided a description of the test apparatus and the test method used for the bench test. The apparatus includes a tire mounting hub that positions the tire vertically at an angle 5 degrees to the vertical axis, a hydraulic-powered sliding wedge-shaped block that applies force to the tire tread surface, and a control panel that includes controls for monitoring and regulating the tire's inflation pressure and a load indicator. The test procedure recommends inflating the tire to an initial inflation pressure of maximum (design) inflation pressure plus 50 kPa. Therefore, the initial inflation pressure for a P205/65R15 standard load tire (rated at a load limit of 635 kg (1400 lbs.) at an inflation pressure of 240 kPa) is 290 kPa. Force, using the wedge-shaped block, is applied at a rate of 200 millimeters per second (mm/s) to a properly mounted tire and is maintained for a duration of 20 seconds. A tire successfully completes the test if there is no [measured] air loss.

Recently the agency has conducted research using the Toyota test apparatus and test to verify that the recommended force levels are appropriate for a minimum safety requirement. Based on the agency's evaluation of this bead unseating method, it proposes 180 kPa for an inflation pressure in P-metric tires and 2.0 times the maximum tire load labeled on the tire sidewall for an application load appropriate for a minimum safety standard. The test inflation pressure for other tires are identical to the inflation pressures used in the proposed endurance test, which specifies 260 kPa, 340 kPa, and 410 kPa for LT tires load range C, D, and E, respectively

The agency has not completed testing a sample of tires to determine the suitability of the test and current compliance with this test.

F. Accelerated Aging Test Requirements

During the Firestone hearings and the passage of the TREAD Act, some members of Congress expressed the view that there is a need for an aging test to be conducted on light vehicle tires. The agency tentatively concludes that we agree there is a need for an aging test in the proposed light vehicle tire standard because most tire failures occur at mileages well beyond 2,720 kilometers (1,700 miles) to which tires are exposed in the current FMVSS No. 109 Endurance Test. The proposed endurance test, while accumulating 4,800 kilometers (3,000 miles) on a tire, still will not expose the tire to the type of environmental factors experienced on vehicles at 40,000 kilometers or beyond.

There are no current requirements for accelerated tire aging in FMVSS Nos. 109 and 119, and no industry-wide recommended practice for accelerating the aging of tires exists. The agency, therefore, proposes the following three alternative tests for consideration and comment: 1) Adhesion Test, 2) Michelin's Long-term Durability Endurance Test, and 3) Oven Aging. NHTSA envisions adopting one of these alternative tests. These tests are discussed in detail below:

Adhesion (Peel) Test (Alternative 1)

The Adhesion (peel) test is based on the American Society for Testing and Materials (ASTM) 413-98, *Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate*. The

Adhesion (peel) test evaluates a tire's resistance to belt separation by determining the adhesion strength, measured by force per unit width, required to separate a rubber layer from a flexible substrate such as fabric, fiber, wire, or sheet metal. The adhesion levels of a tire will vary based on rubber formulations, the different materials used to construct a tire, and the curing process.

The test methods in ASTM D 413-98 cover the determination of adhesion strength between plies of fabric bonded with rubber or adhesion of the rubber layer in articles made from rubber attached to other material. They are applicable only when the adhered surfaces (adjacent tire belts) are approximately plane or uniformly circular in belting, hose, tire carcasses, or rubber-covered sheet metal.

The test methods described in this ASTM standard determine the force per unit (pounds per inch) width required to separate a rubber layer from a flexible substrate such as fabric. There are two general methods for this test:

1) <u>Static-Mass Method</u>: The force required to cause separation between adhered surfaces is applied by means of gravity acting on a mass.

2) <u>Machine Method</u>: The force required to cause separation between adhered surfaces is applied by means of a tension machine.

Due to the greater accuracy of the tension testing machine, the agency proposes to utilize the Machine Method to apply a peel strength requirement for new tires after they complete a 24-hour test with parameters similar to the proposed 40-hour endurance test. The parameters for this 24-hour test are as follows:

1) Ambient temperature - 40°C

2) Load - 90/100/110 percent

3) Inflation pressure - 180 kPa

4) Test speed - 120km/h

5) Duration - 24 hours with three 8-hour periods at each load

For a tire to satisfy the proposed test, it must exhibit a minimum peel strength of 30 pounds per inch at the end of the 24-hour test period. NHTSA tentatively selected this value based on Ford and Firestone data.

Michelin's Long-term Durability Endurance test (Alternative 2)

The alternative 2 accelerated aging method being considered by the agency is based on a method utilized by Michelin. This method uses a road wheel endurance test with the following controlled parameters to simulate testing the tire to tread wear-out: load, inflation pressure, speed, and duration. The test tire is inflated with a 50/50 blend of O_2/N_2 and run for between 250 - 350 hours. Michelin has estimated that this test correlates with approximately one year of real-world tire durability for every 100 hours of testing. For example, a 250-hour test correlates with approximately 2 ½ years of real world field operation.

The Michelin long-term durability endurance test research findings were initially published at a 1985 International Rubber Conference. The research pointed toward four factors as comprising the best balance to achieve good/accurate correlation with field data – 1) filling gas; 2) test speed; 3) test temperature; and 4) tire load. Michelin discovered that if any one or several of these factors was disproportionately altered in an attempt to make the test more stringent or to complete the test faster, the result was a test failure condition that displayed an abnormal failure mode and did not reflect actual field conditions. Therefore, temperature and mechanical stress must be controlled to avoid failures that are not representative of real-world conditions.

The following test parameter values have been developed, through a multi-year research program at Michelin, to minimize variance from field test end conditions and minimize test hours:

1) Filling gas blend: 50 percent O_2 (oxygen) and 50 percent N_2 (nitrogen)

2) Test speed: 97 km/h (60 mph)

3) Test temperature: 38°C (100°F)

4) Load: 111 percent for standard load P-metric tires; 112 percent, 98 percent and 92 percent for LT tires load range C, D, and E, respectively.

5) Inflation pressure: 40 psi (275 kPa) for standard load P-metric tires; 57, 65, and 80 psi (390, 450, 550 kPa) for LT tires load range C, D, and E, respectively.

6) Test duration: 250 hours.

These values were chosen to make each test parameter proportionally severe without exceeding a critical temperature which, in turn, would lead to failure conditions unrepresentative of real-world conditions/ actual field conditions.

The agency has not completed testing to determine current compliance with these tests.

G. Tire Variability Analysis

The agency examined tire variability using the PHASE II data from the Standards Testing Laboratories, Inc. Five tires of the same brand/model were tested in each of the endurance and high-speed tests.

A. Variability in the same production run (production lot), same brand/model Endurance Tests P-Metric Tire Results

By design, endurance tests #1, #2 and #3 represent a progressively increasing scale of stringency. (see the footnote to Table II-12. It would be expected that the same brand/model tires would accumulate more failures moving from Test #1 to Test #2 to Test #3.

- Results: 4 of 8 tire brand/model failures were inconsistent with this theory.
  4 of 8 tire brand/model failures were consistent with this theory.

For the endurance tests, for the same brand/model, the samples of tires selected had the same serial number (i.e., same production run) from test to test with the exception of 3 tire brands having two different serial numbers in the same test or different tests. Three of the tire brand/models (Dunlop D65, Cooper Lifeliner and Michelin XH4) with failure inconsistencies had results confounded by a second serial number representing a different production run. The 4th tire with failure inconsistencies (B.F. Goodrich) had the same serial number tire throughout all endurance tests. [For the purposes of this analysis, serial number (SN) designates a different production run from the same or different assembly plant for a particular tire brand/model.]

These results appear to indicate tire-to-tire variability within the same production run and, as expected, variability across different production runs. Factors that might account for variability include the manual assembly operations used at various points in the construction of a tire (e.g., installation of belts). There could also be rubber compound variations.

B. Variability in the same production run (production lot), same brand/model High Speed Test P-Metric Tire Results

Based on the performance parameters, the high speed tests were re-ordered from "least" stringent to "most" stringent with the result; #2, #4, #1 and #3. (Designated test numbers – see the footnote to Table II-8 for a description of the tests). Test #1 is more stringent than Test #2 because lower tire pressure is a more stringent condition. The design of Test #3 is equal to or more stringent than Test #1 based on the Initial Test Speed (i.e., 6 out of the 8 tires were tested above their speed rating and 2 tires were tested at their speed rating). Finally, the design of Test #4 is slightly more stringent than Test #2 because of a 5 percent higher loading.

It would be expected that the same brand/model tires would accumulate more failures moving from Test # 2 to Test # 4 to Test # 1 to Test# 3. Similar to the endurance test series above, there were tire failures inconsistent with the above theory:

5 of 8 tire brand/model failures were inconsistent with the above theory.

3 of 8 tire brand/model failures were consistent with the above theory.

C. Tire Failures by Test Procedure for the P-Metric Tires

The following Tables (II-14 and II-15) show that; (1) the endurance tests are linearly increasing in stringency based on the number of tire failures, (2) the high speed tests results are not linearly increasing in stringency and (3) a higher percentage of tires failed the high speed tests than the endurance tests for the P-metric tires tested.

Table II-14
Number of Tire Failures for the Endurance Test Procedure

Endurance Tests	#1	#2	#3	Totals
Design Stringency	#1 "Least"	#2	#3 "Most"	
No. of Tire Failures/ Total No. of Tires Tested	4/40	17/40	18/40	39/120
Percent Tire Failures				32.5 %

Table II-15
Number of Tire Failures for the High Speed Test Procedure

High Speed Tests	#1	#2	#3	#4	Totals
Design Stringency	#2 "Least"	#4	#1	#3 "Most"	
No. of Tire Failures/ Total No. of Tires Tested	21/40	8/40	23/40	19/40	71/160
Percent Tire Failures					44.4 %

The "most" stringent high speed test produced fewer failures than the "least" stringent high speed test. This inconsistent result appears to be related to tire-to-tire variability.

The Dunlop D65 tire had zero failures in the more stringent high speed test series, but had one failure in the lesser stringent endurance Test #2. This clear inconsistency may be related to serial number or production run variability as Dunlop D65 endurance Test #2 used the same serial number throughout (C363200) but the Dunlop D65 high speed tests involved 8 different serial numbers excluding C363200. For the Dunlop D65, there was production run to production run variation. [Keep in mind the previous result, for 15 out of 16 of the high speed tests the PASS or FAIL outcome was consistent despite various serial numbers being involved.]

The Uniroyal Tiger Paw Touring tire had zero failures in either the endurance tests or the high speed tests. This implies low tire-to-tire variability. All Uniroyal tires for both test series came from the same production run [i.e., same TIN (tire identification number) BEXOEM9U0501]. Table II-12 was constructed to test the hypothesis that the number of tire failures is proportional to the number of differing serial numbers in the tire test sample.

There appears to be a poor correlation (qualitatively speaking) between the number of brand/model failures and the number of different serial numbered tires used to represent that brand/model in the test procedures. "Production lot" to "production lot" differences don't appear to be a big factor in this data set (i.e., the high speed tests had the greatest number of different serial numbers, but previous analysis showed that 15 out of 16 were consistent in PASS/FAIL outcome.) Therefore, given the consistency among production runs in this case, the variation appears to be due to tire-to-tire variation and test condition differences (endurance vs. high speed). The agency believes that the variation in the test equipment would be minimal.

Table II-16
Tire Failures by Number of Unique Serial Numbers by Brand/Model

Brand/Model	No. of Endurance Test Failures	No. of High Speed Test Failures	Total Failures	Endurance Test, No. of Unique SN s	High Speed Test, No. of Unique SNs
Uniroyal Tiger Paw	0	0	0	1	1
Toyo Proxes H4	0	1	1	1	6
Dunlop D65 Touring	2	0	2	2	8
Cooper Lifeliner Classic II	11*	3	14	2	5
B.F. Goodrich Cientra	3	18	21	1	3
Firestone Wilderness AT	6	15	21	1	4
Michelin XH4	8	15	23	2	5
Goodyear Regatta 2	9	19	28	1	6
Total	39	71	110	11	38

NOTE: Column 5 serial numbers are included in Column 6 serial numbers, generally. So, Column 6 represents the total number of different serial numbers or production runs involved. It is unknown if the different production runs occurred at the same plant (same personnel) or at different plants (different assembly personnel).

Table II-16 shows that the Cooper Lifeliner Classic II tire had 11 failures at the less stringent endurance test series, but only 3 failures in the more stringent high speed test series. This is a clear inconsistency related to tire-to-tire variability. The less stringent test series involved only 2 unique serial numbered Cooper tires, yet the higher stringency tests involved 5 unique serial numbered Cooper tires.

D. LT Tire Test Data

Tables II-17 and II-18 summarize the endurance and high-speed test results for LT tires.

Table II-17
Endurance Test Results -LT Tires

Endurance Tests				
Test Number	#1	#2	#3	
Design Stringency	#1 "Least"	#2	#3 "Most"	
No. of Tire Failures/ No. of Tires Tested	3/20	4/20	7/20	14/60
Percent Failures				23.22 %

* 13 unique tire brand/model serial numbers involved.

Table II-18
High Speed Test Results - LT Tires

High Speed Tests					
Test Number	#1	#2	#3	#4	Totals
Design Stringency	#2 "Least"	#4	#1	#3 "Most"	
No. of Tire Failures /No. of Tires Tested	0/20	1/20	0/20	3/20	4/80
Percent Failures					5 %

* 32 unique tire brand/model serial numbers involved.

Conclusions for LT Tires from Tables II-17 and II-18

1. For the LT tires, the number of tire failures increased as expected in a similar manner to the P-metric tire data for the endurance tests.

2. For LT tires, the number of tire failures increased inconsistently as the tests increased in stringency. Results were mixed. This result is similar to that for the P-metric tires.

3. The high speed tests for the truck tires were less stringent than the endurance tests which is the opposite of the P-metric tire results.

4. Thirteen unique serial numbered truck tires were used for the endurance tests and 32 unique serial numbers were used for the high speed tests.

5. Overall, the Phase II tire test procedures were relatively benign for the truck tires.

E. Repeatability

Repeatability measures the percent variation across one tire brand/model for each unique test procedure. Table II-19 shows the repeatability range across the 8 tire brands tested for both test procedures. As shown in Table II-19, the endurance tests had a much wider range of variability than the high speed tests.

With the finely instrumented test dummies used in NHTSA crash testing, the agency typically expects coefficients of variation of less than +/- 10 percent. When the vehicle is added to the test, some of the specific variations increase into the +/- 20 percent range. The agency is not accustomed to seeing variability as high as those seen in the endurance test for some of the tire brand/models.

Table II-19
Endurance and High Speed Test Procedure Variability
based on "Test Stand Time*"
P-metric Tires
(n=5 tires)

Tire Brand/Model	Endur. #1	Endur. #2	Endur. #3	High Speed #1	High Speed #2	High Speed #3	High Speed #4
Toyo Proxes H4	0**	0	0	5.6	0	0	0
Uniroyal Tiger Paw	0	0	0	0	0	0	0
Dunlop D65	0	8.7	0	0	0	0	0
Goodyear Regatta 2	0	30.7	36	3.4	27.3	10.9	4.2
B.F. Goodrich Cientra Plus	0	11.6	16.2	10.0	9.5	16.2	28.2
Cooper Lifeliner Classic II	0	27.7	33.1	5.1	2.0	0	0
Firestone Wilderness AT	0	41.8	20.9	7.5	7.1	12.5	0
Michelin XH4	0	49.2	44.2	7.6	2.0	6.5	0

* Includes all test stand times (how long the tire stayed in the test) regardless of Pass or Fail outcome of the tire.

** Repeatability expressed as +/- Percent Coefficient of Variation (% CV) = Standard Deviation (S.D.) (n=5) of tire test time (all failures included) divided by the Mean (n=5) tire test time (all failures included) X 100%.

Table II-20
Endurance and High Speed Test Procedure Variability
based on "Test Stand Time*"
LT-Tires
(n=5 tires)

Tire Brand/Model	Endur. #1	Endur. #2	Endur. #3	High Speed #1	High Speed #2	High Speed #3	High Speed #4
Pirelli Scorpion	0**	16.2	24.1	0	0	0	0
Yokohama Geo-Landar	35.2	10.9	0	0	0	0	2.2
Goodyear Wrangler GT	0	0	13.7	0	0	0	0
Bridgestone SWP II	4.2	0.9	16.4	0	0	2.2	0

* Includes all test stand times (how long the tire stayed in the test) regardless of Pass or Fail outcome of the tire.
** **Repeatability** expressed as +/- Percent Coefficient of Variation (% CV) = Standard Deviation (S.D.) (n=5) of tire test time (all failures included) divided by the Mean (n=5) tire test time (all failures included) X 100%.

Conclusion: In Table II-20, the LT tires exhibited less variability. Also, the LT tires had a narrower repeatability range compared to the P-metric tires for both test procedures.

Table II-21 compares the P-metric and LT tire failure rates for both test procedures. The P-metric tires had higher failure rates for both the given test procedures compared to the LT tires tested. The high speed tests are more stringent for the P-metric tries whereas the high speed tests, are less stringent for LT tires.

Table II-21
Summary of The Percent of Tire Failures by Tire Type
Based on the Endurance Test Series and the High Speed Test Series

Tire Type/Test Type	**No. of Failures/Total Number**	**Percent Failures**
P-Metric Car Tire Endurance Tests	39/120	32.5 %
P-Metric Tire High Speed Tests	71/160	44.4 %
LT Tire Endurance Tests	14/60	23.33%
LT Tire High Speed Tests	4 /80	5.00%

III. TARGET POPULATION

Safety Problems Associated With Tires

There is no direct evidence in NHTSA's crash data files that points to defective or sub-standard tires as the cause of a particular crash. The closest data element is "flat tire or blowout". Even in these cases, crash investigators do not record what caused the tire failure. Tire failures, especially blowouts, are typically associated with rollover crashes.

It is possible that a combination of lesser quality tires (lesser quality being defined here as designs that do not adequately dissipate heat, which causes the tire to rapidly build-up heat which ultimately causes the tire failure) being operated in an under-inflated state and/or an overloaded state could account for many of the tire failures, since both under-inflation and overloading increase heat build-up in the tire. Severe under-inflation coupled with an emergency steering maneuver could cause the tire to "de-bead," i.e., separate from the rim, which could "trip" the vehicle and cause it to roll over.

The Target Population for General Tire-Related Crashes

The agency examined its crash files to gather available information on tire-related problems causing crashes. The 1977 Indiana Tri-level study investigated 2,258 crashes on-site and 420 crashes in-depth and found 3 cases (0.1 percent) where tire blowout was a certain or probably cause of the crash. However, there is no information as to what caused the blowout in the crash investigations.[1] At the time of the study, radial tires

[1] **Tri-level Study of the Causes of Traffic Accidents: Executive Summary,** Treat, J.R., Tumbas, N.S., McDonald, S.T., Shinar, D., Hume, R.D., Mayer, R.E., Stansifer, R.L., & Castellan, N.J. (1979). (Contract No. DOT HS 034-3-535). DOT HS 805 099. Washington, DC: U.S. Department of Transportation, NHTSA.

represented only 12% of the tire population and now they are more than 90%, including all tires on new light vehicles. Therefore, the 1977 results may not be applicable in today's tire environment.

The National Automotive Sampling System - Crashworthiness Data System (NASS-CDS) has trained investigators that collect data on a sample of tow-away crashes around the country. These data can be extrapolated to national estimates. The NASS-CDS contains on its General Vehicle Form the following information: a critical pre-crash event, vehicle loss of control due to a blowout or flat tire. This category only includes part of the tire-related problems causing crashes. This coding would only be used when the tire went flat rapidly or there was a blowout which caused a loss of control of the vehicle, resulting in a crash.

NASS-CDS data for 1995 through 1998 (with predominately radial tires) were examined and average annual estimates are provided below in Table III-1. Table III-1 shows that there are an estimated 23,464 tow-away crashes caused per year by blowouts or flat tires. Thus, about one half of one percent of all crashes are caused by these tire problems. The denominator for the right hand column of Table III-1 is all crashes by the vehicle type in the row. When these cases are broken down by passenger cars versus light trucks, blowouts cause more than three times the number of crashes in light trucks (0.99 percent) than in passenger cars (0.31 percent). Blowouts cause a much higher proportion of rollover crashes (4.81 percent) than non-rollover crashes (0.28 percent); and the rate in light trucks (6.88 percent) is more than three times the rate in passenger cars (1.87 percent).

Table III-1

	Tire Related Cases	Percent Tire Related
Passenger Cars Total	*10,170*	*0.31%*
Rollover	1,837 (18%)	1.87%
Non-rollover	8,332 (82%)	0.26%
Light Trucks Total	*13,294*	*0.99%*
Rollover	9,577 (72%)	6.88%
Non-rollover	3,717 (28%)	0.31%
Light Vehicles Total	*23,464*	*0.51%*
Rollover	11,414 (49%)	4.81%
Non-rollover	12,049 (51%)	0.28%

Estimated Annual Average Number (1995-98 NASS) and Rates of Blowouts or Flat Tires Causing Tow-away Crashes

Table III-2 shows the estimated number of fatalities and injuries in those cases in which a flat tire/blowout was considered the cause of the crash[2]. There are an estimated 414 fatalities and 10,275 non-fatal injuries in these crashes.

We examined these crashes by speed limit of the highway, knowing that the heat build-up is related to speed. Of the 414 fatalities, 306 (74 percent) occurred on highways with posted speed limits of 55 mph or higher. Of the 10,275 injuries, 6,590 (64 percent) occurred on highways with posted speed limits of 55 mph or higher.

[2] Since CDS typically underestimates the number of fatalities, a factor of 1.163 was developed based on the number of occupant fatalities in FARS divided by the number of occupant fatalities in CDS for those years. The actual estimate of flat tire/blowout fatalities were multiplied by the1.163 factor.

Table III-2
Injuries/Fatalities in Crashes Caused by
Flat Tire/Blowout

	Non-fatal AIS 1	Non-fatal AIS 2	Non-fatal AIS 3	Non-fatal AIS 4	Non-fatal AIS 5	Fatalities
Number of Injuries	8,231	1,476	362	155	51	414

The Fatality Analysis Reporting System (FARS) was also examined for evidence of tire problems involved in fatal crashes. In the FARS system, tire problems are noted after the crash, if they are noted at all, and are only considered as far as the existence of a condition. In other words, in the FARS file, we don't know whether the tire problem caused the crash, influenced the severity of the crash, or just occurred during the crash. For example, (1) some crashes may be caused by a tire blowout, (2) in another crash, the vehicle might have slid sideways and struck a curb, causing a flat tire which may or may not have influenced whether the vehicle rolled over. Thus, while an indication of a tire problem in the FARS file gives some clue as to the potential magnitude of the tire problem in fatal crashes, it can neither be considered the lowest possible number of cases nor the highest possible number of cases. In 1995 to 1998 FARS, 1.10 percent of all light vehicles were coded with tire problems. Light trucks had slightly higher rates of tire problems (1.20 percent) than passenger cars (1.04 percent). The annual average number of vehicles with tire problems in FARS was 535 (313 in passenger cars and 222 in light trucks). On average, annually there were 647 fatalities in these crashes (369 in passenger cars and 278 in light trucks). Thus, these two sets of estimates seem reasonably consistent: 647 fatalities in FARS in crashes in which there was a tire problem and 414 fatalities from CDS, in which the flat tire/blowout was the cause of the crash.

Geographic and Seasonal Effects

The FARS data were further examined to determine whether heat is a factor in tire problems (see Table III-3). Two surrogates for heat were examined: (1) in what part of the country the crash occurred, and (2) in what season the crash occurred. The highest rates occurred in light trucks in southern states in the summer, followed by light trucks in northern states in the summer, and by passenger cars in southern states in the summer. The lowest rates occurred in winter and fall. The denominator is all passenger cars or light trucks in fatal crashes by season. It thus appears that tire problems are heat related.

Table III-3

Geographic and Seasonal Analysis of Tire Problems
(Percent of Vehicles) in FARS with Tire Problems

	Passenger Cars	Light Trucks	All Light Vehicles
Northern States			
Winter	1.01%	0.80%	0.94%
Spring	1.12%	1.01%	1.08%
Summer	0.98%	**1.46%**	1.15%
Fall	1.04%	0.93%	1.00%
Southern States			
Winter	0.87%	0.99%	0.92%
Spring	1.09%	1.27%	1.16%
Summer	**1.31%**	**1.99%**	1.59%
Fall	0.89%	1.07%	1.00%

Winter = December, January, February.
Spring = March, April, May
Summer = June, July, August
Fall = September, October, November.

Southern States = AZ, NM, OK, TX, AR, LA, KY, TN, NC, SC, GA, AL, MS, and FL.
Northern States = all others.

Tire Problems by Tire Type and Light Truck Type

The agency also examined tire problems in the NASS-CDS database from 1992 to 1999 by types of light trucks and vehicle size to determine whether LT tires used on light trucks had more tire problems than P-metric tires. Table III-4 provides the results of this analysis, showing the unweighted number of cases. The unweighted numbers are used since in this case, as sometimes happens when NASS data are broken up into a small number of cells, the results obtained using weighted numbers do not appear to be logical.

LT tires are used on the vehicle classes we have identified for this analysis as Van Large B and Pickup Large B groups of vehicles. These groups of vehicles typically represent the ¾-ton and 1-ton vans and pickups. P-metric tires are used on most other light trucks. The data indicate that the average percent of the light trucks in NASS-CDS that have an LT tire problem is 0.84 percent (10/1,186), while the average percent of the light trucks that have a P-metric tire problem is 0.47 percent (53/11,226). Of course larger pickups and vans are also the vehicles that carry the heavier loads and may be more likely to be overloaded than other light trucks. In addition, these heavier vehicles are often used at construction sites and may be more apt to pick up nails resulting in flat tires. Thus, there may well be driver behavior issues that drive the percentage of tire problems up for these larger trucks, rather than any qualitative difference between P-metric and LT tires.

Table III-4

Tire Problems by Light Truck Vehicle Type
1992 to 1999 NASS-CDS Data
Unweighted Data

Light Truck Type	Number of Cases with a Tire Problem	Total Number of Cases	Percent of Cases with a Tire Problem
Van – Compact	11	2,125	0.52
Van – Large A	3	431	0.70
Van – Large B	4	501	0.80
Pickup – Compact	13	3,155	0.41
Pickup – Large A	7	1,849	0.38
Pickup – Large B	6	685	0.88
SUV – Compact	16	3,147	0.51
SUV – Large	3	519	0.58
Total	63	12,412	0.51

The Van – Large A group includes vehicles like the Ford Econoline - 150
The Van – Large B group includes vehicles like the Ford Econoline – 250/350
The Pickup – Large A group includes vehicles like the Ford F-150
The Pickup – Large B group includes vehicles like the Ford F-250/350

Crashes Indirectly Caused by Tire Problems

There are also crashes indirectly caused by tire related problems. If a vehicle stops on the side of the road due to a flat tire, there is the potential for curious drivers to slow down to determine the reason for the stopped vehicle. This can create congestion, potentially resulting in a rear end impact further back in the line of vehicles when some driver isn't paying enough attention to the traffic in front of him/her

Another crash type indirectly caused by tire problems involve crashes relating to incidents on the road when a driver is in the act of changing a tire on the shoulder of the road. Sometimes drivers changing tires are struck (as pedestrians) by other vehicles. This phenomena is not captured in NHTSA's data files, but there are three states

(Pennsylvania, Washington, and Ohio) which have variables in their state files which allow you to search for and combine codes such as "Flat tire or blowout" with "Playing or working on a vehicle" with "Pedestrians". An examination of these files for calendar year 1999 for Ohio and Pennsylvania and for 1996 for Washington found the following information shown in Table III-5.

Table III-5
State data on tire problems and pedestrians

	Ohio	**Washington**	**Pennsylvania**
Pedestrians Injured	3,685	2,068	5,226
Pedestrians Injured While Playing or Working on Vehicle	50 (1.4%)	27 (1.3%)	56 (1.1%)
Pedestrians Injured While Working on Vehicle with Tire Problem	0	2	0
Total Crashes	385,704	140,215	144,169
Crashes with Tire Problems Not Coded in GES	862 (0.22%)	1,444 (1.03%)	794 (0.55%)

The combined percent of total crashes with tire problems of these three states (3,100/670,088 = 0.46 percent) compares very favorably with the NASS-CDS data presented in Table III-1 of 0.51 percent. The portion of pedestrians coded as being injured while working on a vehicle with tire problems is 2/10,979 = 0.018 percent. Applying this to the estimated number of pedestrians injured annually across the U.S. (85,000 from NASS-GES), results in an estimated 15 pedestrians injured per year due to tire problems. The agency does not have data to estimate how many of the pedestrian injuries could be reduced by having better tires.

IV. BENEFITS

There are many factors that influence crashes caused by flat tires/blowouts, including speed, tire pressure, and the load on the vehicle. Blowouts to the front tire can cause roadway departure, or can cause a lane change resulting in a head-on crash. Blowouts in a rear tire can cause spinning out and loss of control. As discussed in the target population section, a target population can be estimated for tire problems, but the agency doesn't know how many of these crashes are influenced by tire design or under-inflation. The agency's best estimates of these effects are discussed below.

The target population is 414 fatalities and 10,275 non-fatal injuries that occur annually in light vehicles in which the cause of the crash is a flat tire/blowout. Puncture is the most common reason for a blowout. However, there are also many cases where a tire is punctured, loses air, and then fails later after being driven a distance under-inflated. There are no data on whether the tire failed because of a nail puncture, hitting a curb, de-beading, low tire pressure with or without overloading, or normal wear out. Thus, it is difficult to estimate what percent of the tire problem crashes are the result of tire failure modes that might be affected by this proposal.

In the Tire Pressure Monitoring System (TPMS) analysis, the agency assumed that under-inflation is involved in 20 percent of the cases that caused the crash. The agency assumed that the influence that under-inflation has on the chances of a blowout are influenced by both tire pressure and the properties of the tire. Thus, we assumed that better inflation would take care of 50 percent of these cases and we assumed that better tires could take care of 50 percent of this problem. Thus, 41 fatalities (414 x .2 x .5) and 1,028 injuries were assigned to the TPMS rule. This leaves the target population for this rule at 373 fatalities and 9,247 injuries.

The impact of the proposed rule will be to increase the strength, endurance, and heat resistance of tires by strengthening the standards on road hazard, bead unseating, endurance, high speed tests, and by adding an aging requirement. The impact of strengthening the standards is that certain tires would be eliminated from the U.S. marketplace. Although there is not a direct one-for-one correlation, the agency believes that P-metric tires that could not pass the proposal would currently be rated either B or C for temperature resistance under the Uniform Tire Quality Grading System (UTQGS). The recalled Firestone tires that were used on the Ford Explorer are C-rated for temperature resistance and did not pass the test protocols proposed for the agency's test program.

Table IV-1 shows our estimate of how many tires would have failed the combination of high speed and endurance tests under the different alternatives. Tires had to pass both tests to be considered as passing the proposed tests. There were 15 P-metric tires tested and 7 LT tires tested for both high speed and endurance.

Table 1
Estimated Percentage of Tires Failing the Alternative Tests

P-Metric Tires	Alternative 1	Alternative 2	Alternative 3
High Speed Test	0	13% (2 of 15)	33% (5 of 15)
Endurance Test	0	20% (3 of 15)	60% (9 of 15)
Both Tests	0	33% (5 of 15)	67% (10 of 15)
LT-Tires			
High Speed Test	0	0	71% (5 of 7)
Endurance Test	0	29% (2 of 7)	86% (6 of 7)
Both Tests	0	29% (2 of 7)	86% (6 of 7)

For the proposed Alternative 2 endurance test, out of the 15 P-metric tires tested, we estimate that three would have failed, two B-rated tires and a C-rated tire[1]. For the high-speed test, 2 different P-metric tires probably would have failed, a B-rated tire and a C-rated tire[2]. Out of the 7 LT-tires tested, two would have probably failed the endurance test (LT tires are not rated for UTQGS) and none would have probably failed the high-speed test.

Approximately 1,700 different P-metric tire models were rated in the UTQGS for 1999. Of those tire models, 328 (19 percent) have a C-rating for temperature resistance, about 50 percent have a B-rating for temperature resistance, and about 31 percent have an A-

[1] For Alternative 2, the bases for assuming a tire would fail the endurance test were tests where the speed and kPa were as proposed, and there was a failure during the time or within one hour of the time that the tire was tested at up to 110% of load. For example, when the load was 100% and 110% for 8 and 10 hours, respectively, and the failure occurred in less than 19 hours, we assumed this tire would fail the proposed test.

[2] For Alternative 2, the bases for assuming a tire would fail the high speed test were when the test conditions were 85% load at 220 kPa, and the failure occurred during the 160 km/h portion of the test, or some equivalent values.

rating for temperature resistance. The agency has no sales data for these tire models, so it does not know what percent of tires sold are C-rated, B-rated, or A-rated tires. Each tire model is required to pass all of the tests. Given the test data we have on endurance and high speed (where both C-rated tires tested probably would have failed and where three of seven B-rated tire models might have failed the proposed test), the agency assumes that 33 percent of the P-metric tire models (not sales) would fail the proposed test (5 of 15 total tires tested failed) = 33 percent. Weighting all C-rated tires (17 percent) and 3 of 7 B-rated tires (43 percent times 50 percent) = 38.5 percent, not very different from the straight percentage of tires tested of 33 percent and the weighted estimate assumes that all C-rated tires would fail the proposed test based on testing only 2 of the 328 C-rated models).

There are approximately 5,000 LT tire models are in the marketplace. The test data we have on endurance and high speed indicate that two of the seven (29 percent) of the LT tires tested would probably not have passed the proposed Alternative 2 test. Weighting P-metric and LT tires results in the estimate that 32.8 percent (33% * .95 + 29% * .05) of the light vehicle tires would not have passed the proposed Alternative 2 test.

Obviously, the agency needs much more test data on P-metric and LT tires to better understand what percent of the tire models or what percent of the tire sales would not pass the proposed set of tests. Comments providing test data and sales data are requested.

While it is intuitively correct to upgrade the tire standards (i.e., stronger tires will lead to less blowouts, tire failures, and de-beading problems), the agency cannot make a direct link between the present standard and the proposed upgrade of the standard, in terms of tire failures. Obviously, Alternative 1 would result in no benefits, since we estimate that all of the tires tested would have passed the test criteria for this alternative.

Alternative 3 would intuitively result in more benefits than Alternative 2, since the test criteria are more stringent and more tires fail Alternative 3 testing. The only tires that passed the Alternative 3 criteria are A-rated tires for temperature (and one A-rated tire failed the Alternative 3 criteria). Thus, if the agency chose Alternative 3, it appears that the only tires that could be sold would be A-rated tires for temperature. Again, the agency cannot quantify how much improvement in benefits there would be for Alternative 3 compared to Alternative 2.

One comparison that the agency can make is to consider the results of the high-speed tests that were run to failure in the Phase 1 testing and compare the times it took for the tires to fail compared to the proposal. The proposal (Alternative 2) is for a 90 minute high speed test. For P-metric tires, the average times to failure (see Table II-4) for the six test series where the tires were run to failure were 93 minutes for A-rated (for temperature resistance) tires, 100 minutes for B-rated tires, 72 minutes for C-rated tires, and 108 minutes for LT tires. If the two C-rated tires that were tested were representative of all C-rated tires, and the proposed level was compared to the average of the six test series, then the average C-rated tire would need to be improved by 25 percent (90/72 - 1) to meet the proposed high-speed test. However, the proposal is not an average of the six tests run (proposed at 85% load and 220 kPa), but is closer to an average of the four tests (80% load at 210 and 240 kPa, and 90% load at 210 and 240 kPa). Since the tests at 210 kPA were not run to failure, but were stopped after 90 minutes if the tire did not fail sooner, a fair comparison could not be made which would allow a better estimate of how much improvement will be needed for C-rated tires. However, ignoring the bias that results from stopping the 210 kPa test at 90 minutes, the average of these four tests (87, 88, 100, and 60) for C-rated tires is about 84 minutes, which means that the average C-rated tire would need to improve by about 7 percent (90/84 – 1) to meet the proposal.

It is hard to use the endurance tests to determine how much improvement is needed to pass, since the Phase 2 tests were run at higher loads than proposed. Many of the failures occurred very close to what the agency considered a passing grade. However, there was considerable variability in the tires tested and reducing that variability will be a considerable benefit in reducing tire failure.

For LT tires, there were no failures in the high-speed test, the only failures were in the endurance test. Two Goodyear Wrangler tires failed very quickly in different endurance tests. The other failure occurred very close to what the agency considered a passing grade.

Based on the tires tested, and comparing how well the tires did in the tests compared to what the agency estimates they need to do to pass the proposed tests (Alternative 2 high-speed test and Alternative 2 endurance test), the agency estimates that the high speed test will improve tire safety by about 7 percent and the endurance test will improve tire safety by about 15 percent. The agency considers these results additive, such that the total benefit from these two tests will be 22 percent for those tires that currently don't pass the test.

There are four other tests that the agency either believes the benefits will be low or that we cannot quantify currently. Based on preliminary testing of a small sample of tires, all of the tires tested met the proposed upgraded road hazard impact test and de-beading test. Thus, we anticipate zero to minimum benefit from upgrading these two tests. The agency has not done enough testing for the aging test to form an opinion of its potential benefits. The low pressure – endurance test would have no benefit, since all of the tires tested passed. The failure margin for the low pressure – high-speed test appears to be very high. Benefits for this test cannot be easily characterized. There is some overlap of the benefits for this test and the benefits of the high speed and endurance test and the tire pressure monitoring system.

It appears that there is significant variability in tires and if this variability can be reduced, many of the failed tires could pass the proposed test.

The problem the agency has in estimating benefits is that while the agency knows intuitively that any improvement in how tires do in these tests will improve safety, it does not know how to translate the test improvement into real world benefits. Furthermore, it is hard to estimate what improvement might occur if variability in tires were reduced in the real world. Will the impact be large or small? Comments are requested to help answer this question.

At this time, the agency knows that improving tires will be beneficial in reducing tire failures and crashes resulting from tire failures. The question is, do these upgraded requirements result in tires avoiding a heat-related or structure related problem long enough that the tire is discarded because of a worn tread or some other reason before it fails.

We have made an estimate of the target population. There are an estimated 373 fatalities and 9,247 injuries in the target population. However, we do not have a good estimate of effectiveness. Assuming that the improvement needed to pass the high-speed and endurance tests (estimated to be 22 percent) related to a reduction in flat tires/blowouts, the total potential improvement would be 82 lives saved (373 * .22) and 2,034 injuries avoided if only those tires in the target population were those that needed improvements. If the tires having flats and blowouts were a random selection of all tires and only benefits accrued to those tires currently not passing Alternative 2 (weighted to be 32.8 percent), then the benefits would be 27 lives saved (373 * 0.22 * 0.328) and 667 injuries reduced.

The 27 lives saved and 667 injuries reduced are estimated to be the benefits of the high-speed test and the endurance test.

The agency examined the UTQGS ratings for temperature resistance, traction, and tread-wear to determine if there is a correlation between these factors. The question was whether there would be other safety benefits if many of the tires rated low for temperature resistance were taken off the market. However, no correlation was found between temperature resistance rating and tread wear, nor between temperature resistance rating and traction.

V. COSTS AND LEAD TIMES

Tire Costs

The proposed tests will result in tires being designed that are less susceptible to heat build-up. The agency believes that many, if not all, of the P-metric tires rated C for temperature resistance, some P-metric tires rated B for temperature resistance and some LT tires will not be able to pass the proposed new tests (Alternative 2). The agency has attempted to determine the difference in prices between two tires that appear to be essentially the same in all characteristics, except one is a B-rated tire and the other is a C-rated tire for temperature resistance. However, it appears that there are very few cases where every notable attribute (comparing tire size, warranty provided, treadwear, and traction) of two different tires are the same except for the temperature resistance rating.

The manufacturers have different options for improving the heat resistance of tires, many of these options would include a combination of trade-offs in traction, treadwear and rolling resistance. One method would be to change the design of the core of the tire. A second method would be to reduce the amount of tread on the tire. In general, the smaller the amount of tread, the lower the heat build-up. This strategy has obvious implications on treadwear and it could also reduce the wet traction characteristics of the tire. However, the agency does not know the relationship between the amount of tread on the tire and heat build-up. Comments are requested on how much decrease in treadwear would be required to make a tire that would otherwise fail the proposed tests be capable of passing the proposed tests.

The consumer cannot detect the difference in tire design. However, the consumer will notice that there is a difference in pricing and marketing between the A, B and a C-rated tires for temperature resistance. The agency estimates that the difference in price between a B or C-rated tire that may fail the proposed standard and a B-rated tire that would pass the proposed standard is $3 per tire (in 2001 dollars). This estimate is based on two considerations. First, the amount by which these tires are failing the tests are not large and the agency assumes that the changes to the tire to make them pass the tests would also not be large. Second, the agency attempted to get a feel for the tire market and what it means to pricing to be a C-rated versus B-rated tire. This difference in price did not appear to be large. Comments are requested on this estimate. Thus, for a new vehicle that was equipped with C-rated tires, the difference would be $12 to $15 per vehicle depending upon whether it has a full-size spare tire or not[1]. The agency does not know how consumers would value a loss of treadwear or traction, compared to the reduction in the price of the tire, if the method of decreasing the amount of tread on the tire were used to make a tire meet the proposed requirements.

The $3 per tire estimate is for the combination of high-speed and endurance tests. As discussed in the benefits section, it appears that most or all of the current tires would meet the upgraded road hazard impact test and de-beading test. Thus, we don't anticipate an increase in costs for those tests. The agency has not done enough testing for the aging test to form an opinion of its potential costs. However, many tire manufacturers already perform an aging test. The agency is considering an aging test run by Michelin. If most manufacturers already perform an aging test, and if the agency selects a test that is about the same stringency as the manufacturer's aging tests,

[1] The agency is not proposing to require temporary spare tires to meet the proposal. The agency has not tested any temporary spare tires, however, the agency suspects that temporary spare tires could not meet the proposed tests. So, the agency will address temporary spare tires in a separate rulemaking.

then the price of this test is already in the price of the tires. Since the price of Michelin tires does not appear to be out of line with other manufacturers, it is likely that the incremental cost of adding an aging test will be minimal. The low pressure – endurance test would have no cost, since all of the tires tested passed.

The failure margin for the low pressure – high-speed test appears to be very high. Costs for this test cannot be easily characterized. There is some overlap of the costs for this test with the costs of the high-speed and endurance test. The agency requests comments on the incremental cost of meeting this test over and above the high-speed and endurance tests. One of the possible high-cost countermeasures for meeting this test would be to increase the tire size used on the vehicle to get more tire reserve load. The incremental cost of increasing a tire size depends upon the initial size and price of the tire. For the smallest/cheapest P-metric tires, increasing a tire size increases price by about $1 per tire. For the larger P-metric tires, increasing a tire size increases price by $3 to $5 per tire and for an LT tire, the price increase would be $5 to $10 per tire. Comments are requested upon what countermeasures would be needed to pass this test and their costs.

C-rated tires will often be marketed as the least expensive tires available. Since only a portion of new vehicles are equipped with tires that would not meet the proposed standard, we can estimate the average price increase for new vehicles by comparing those vehicles that would get improvements at $3 per tire with those vehicles whose tires and prices wouldn't change. In Chapter IV, we estimated that 33 percent of P-metric tires and 29 percent of LT tires might not pass the proposed standard. Based on the data presented in Table III-3 for all crashes by light truck type, we estimate that 10 percent of light trucks have LT tires. Since future sales are estimated to be split evenly between passenger cars and light trucks, 5 percent of all light vehicles (10% * 0.5) would be equipped with LT tires. Thus, it is assumed that 32.8 percent of all light vehicle tires would not meet the proposed standard (0.33 * 95% of sales + 0.29 * 5% of sales). Thus, the cost of this proposed standard per average new vehicle would be $3.94 to $4.92 per vehicle ($12 * 0.328 to $15 * 0.328). The range reflects whether the vehicle comes equipped with a temporary spare or full-sized spare tire. The agency estimates that about 85 percent of the light vehicle fleet (passenger cars, pickups, SUVs and vans) comes equipped with a temporary spare tire. Thus, the average cost for the new vehicle fleet would be $4.09 ($3.94 * 0.85 + $4.92 * .15).

The tires rated C for temperature resistance appear to be among the lowest priced tires on the market. Thus, if this proposal resulted in the lowest priced new tires being taken off the market, it could have marketing effects on the new vehicle and aftermarket tire sales. This is because there are alternatives to buying new tires. These alternatives include temporary spare tires for new vehicles and re-treaded tires and used tires in the aftermarket. For new vehicles, it is possible, but unlikely, that the increase in price for a full-size tire could persuade some companies to provide a temporary spare tire rather than a full-size spare tire. Currently, most new vehicles are equipped with a temporary spare tire. The main exception is pickup trucks, most of which have a full-size spare, where we don't think manufacturers will change their policy toward temporary spares since consumers want a full-size spare to carry loads if need be. The other exception is in higher priced passenger cars, which typically use better tires that would already pass the proposed tests. Thus, the price of the tires they use would not be affected by this proposal.

In the aftermarket, there are many reasons why people buy the least expensive tire that will fit their vehicle. The reasons include: price alone, they do not plan to keep the vehicle long, one tire was damaged and the other three still have a fair amount of useful life, etc. If the least expensive new tire becomes more expensive, there is a bigger opportunity for alternatives to new tires (used tires and re-treaded tires) to make further inroads into the market. It is difficult to judge how substantial these impacts would be. At this time there are very few re-treaded tires sold for passenger cars and light trucks.

Total Annual Costs

It is assumed that if the cost of the lowest price tires increases by $3 per tire, then the lowest price aftermarket tire will also increase by $3 per tire. The agency estimates that 32.8 percent of the combined sales of P-metric brands LT tires would not pass the proposed requirements. There are approximately 300 million light vehicle tires sold per year. Approximately 13 million of those are temporary spare tires that are not included in this proposal (assuming 15.5 million light vehicle sales per year * 0.85 with temporary spare tires). Thus, there are an estimated 287 million light vehicle tires sold of which 32.8 percent might increase in price by $3 per tire. The total annual cost is thus estimated to be $282 million (287 million tires * .328 * $3).

There are no costs for Alternative 1, since the agency estimates that all tires would pass those testing criteria. The costs for Alternative 3 are much more difficult to estimate. In order to pass

Alternative 3, there would be a large upgrade from the B and C-rated tires for temperature to the A-rated tires for temperature. The cost per tire could be in the $10 to $20 range (comments are requested on these estimates).

Testing Costs

There are six tests proposed with which every tire would be required to comply. This section compares the time it takes to run these tests to the time required for the current tests.

1) The high-speed test currently runs for 90 minutes and the proposed test would run for 90 minutes. Thus, there is no change anticipated in testing costs.
2) The high-speed, low-inflation test is a new proposal that is run after the endurance test for a 90 minute period. (see cost discussion below)
3) The endurance test is currently run for 34 hours for P-metric tires and 47 hours for LT tires. The weighted average time is 35 hours (34*0.9 + 47*0.1). The proposed endurance test will run for 40 hours. (see cost discussion below)
4) The road hazard impact test is a replacement for the strength test. The agency believes it will take approximately the same amount of time to run either test, so no change in testing costs is anticipated.
5) The bead unseating test will require a different test apparatus than is currently being used. However, the agency believes it will take approximately the same amount of time to run either test, so no change in testing costs is anticipated.

   The bead unseating test will require a different test apparatus than is currently being used. Thus, overall, the agency believes the proposal will increase test time by 6.5 hours (40-35 hours for the endurance test plus 90 minutes for the high-speed, low-inflation test.

6) The tire aging testing costs are unknown at this time until a definite proposal has been determined.

Labor costs are estimated to be $75 per hour for a manager, $53 per hour for a test engineer and $31 per hour for technicians. We do not anticipate that the test manager will be required to spend any more time on the proposed set of tests than on the current set of tests, once the tests are set up. It is anticipated that the test engineer and technician will be involved in running the high-speed low-inflation test for 90 minutes and just the technician will be used for the additional last 5 hours of the endurance test. Thus, incremental test costs are estimated to be $281 per tire tested (1.5 hours * [$53 + $31] + 5 hours * $31). For the early warning rulemaking, the Rubber Manufacturers Association provided NHTSA with an estimate of the number of individual tires made in a year based on SKU numbers, which give individual numbers based on the brand names, tread, ply, fabric, speed rating, and tire size. There are 16,924 P-metric tires and 5,235 LT tires. Thus, there are 22,159 individual tires made a year. Some of these tires are the same, but the brand names are changed and most tires would remain the same for 3-4 years before they are changed. Thus, at the most, 25 percent of the tires would be tested on a yearly basis, or 5,540 tires. Thus, the incremental testing cost is $1,556,740 ($281 * 5,540 tires). This cost is less than one cent per tire when divided by the 285 million tires sold per year.

Lead Time

Section 10 of the TREAD Act requires the agency to issue a final rule on this tire upgrade proposal by June 1, 2002. Congress did not set a lead time by which all tires would be required to meet the new standard. The agency anticipates that many P-metric tires rated C for temperature will either be taken off the market or redesigned to pass the proposed standard. Similarly, the agency anticipates that a larger percentage of LT tires will need to be redesigned to pass the proposed standard. Thus, the agency is proposing that LT tires have an additional year to comply with the proposed standard.

The agency is proposing two alternative phase-in implementation schedules:

For the two-year phase-in schedule:

All P-metric tires must comply with the final rule by September 1, 2003.

All LT tires must comply with the final rule by September 1, 2004.

For the three-year phase-in schedule:

50 percent of P-metric tires must comply with the final rule by September 1, 2003.

All P-metric tires must comply with the final rule by September 1, 2004.

All LT tires must comply with the final rule by September 1, 2005.

VI. SMALL BUSINESS IMPACTS

A. Regulatory Flexibility Act

The Regulatory Flexibility Act of 1980 (5 U.S.C. §601 et seq.) requires agencies to evaluate the potential effects of their proposed and final rules on small businesses, small organizations and small governmental jurisdictions. The agency does not believe that any of the tire manufacturers are small businesses.

However, there are thousands of small tire retail outlets that will in some small way be impacted by this rule. As mentioned earlier, increasing the price of the least expensive tires could potentially allow used tires and retread tires to make more inroads into the tire business. This could impact small businesses. At this time, it is unknown whether the impacts will be insignificant and just an increase in price to customers, or whether there will be some competitive effects brought about by the price increase.

B. Unfunded Mandates Reform Act

The Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditures by State, local or tribal governments, in the aggregate, or by the private sector, of more than $100 million annually (adjusted annually for inflation with base year of 1995). Adjusting this amount by the implicit gross domestic product price deflator for the year 2000 results in $109 million (106.99/98.11 = 1.09). The assessment may be included in conjunction with other assessments, as it is here.

This proposal is not estimated to result in expenditures by State, local or tribal governments of more than $109 million annually. However, it is likely to result in the expenditure by automobile manufacturers and/or their tire suppliers of more than $109 million annually. The estimated annual cost is $282 million.

These effects have been discussed in this Preliminary Economic Assessment, see for example the chapter on Costs.

VII. COST EFFECTIVENESS

This section combines costs and benefits to provide a comparison of the estimated injuries and lives saved per net cost. Tire costs occur when the tire is purchased, but benefits accrue over the lifetime of the tire. Benefits must therefore be discounted to express their present value and put them on a common basis with costs.

In some instances, costs may exceed economic benefits, and in these cases, it is necessary to derive a net cost per equivalent fatality prevented. An equivalent fatality is defined as the sum of fatalities and nonfatal injuries prevented converted into fatality equivalents. This conversion is accomplished using the relative values of fatalities and injuries measured using a "willingness to pay" approach. This approach measures individuals' willingness to pay to avoid the risk of death or injury based on societal behavioral measures, such as pay differentials for more risky jobs.

Table VII-1 presents the relative estimated rational investment level to prevent one injury, by maximum injury severity. Thus, one MAIS 1 injury is equivalent to 0.0038 fatalities. The data represent average costs for crash victims of all ages. The Abbreviated Injury Scale (AIS) is an anatomically based system that classifies individual injuries by body region on a six point ordinal scale of risk to life. The AIS does not assess the combined effects of multiple injuries. The maximum AIS (MAIS) is the highest single AIS code for an occupant with multiple injuries.

Table VII-1

Comprehensive Fatality and Injury Relative Values	
Injury Severity	1994 Relative Value* per injury
MAIS 1	.0038
MAIS 2	.0468
MAIS 3	.1655
MAIS 4	.4182
MAIS 5	.8791
Fatals	1.000
* includes the economic cost components and valuation for reduced quality of life	

Source: "The Economic Cost of Motor Vehicle Crashes, 1994", NHTSA, 1996.

In Chapter IV the benefits of 27 lives saved and 667 injuries reduced were estimated. There will be additional benefits that cannot be quantified. The injuries can be divided into the following AIS levels, based on the distribution of AIS levels in the target population as follows:

Table VII-2
Distribution of Injury Benefits

AIS 1	AIS 2	AIS 3	AIS 4	AIS 5	Total
534	96	23	10	4	667

Table VII-3 shows the estimated equivalent fatalities. The injuries benefits are weighted by the corresponding values in Table VII-1, added to the fatalities, and then summed.

Table VII-2
Equivalent Fatalities

Fatality Benefits	Injury Benefits	Equivalent Fatalities
27	18	45

Costs

The annual tire costs are estimated to be $282.

Net Cost/Equivalent Fatality Before Discounting

$282 mil/45 equivalent fatalities = $6.3 million per equivalent life

It must be emphasized that not all benefits could be quantified. The agency believes there will be other benefits that could not be quantified currently from the aging test and overloading of vehicles, that there potentially could be large benefits from the low tire inflation test, and that there will be some small benefit from the puncture resistance test and the de-beading test.

Appendix V of the "Regulatory Program of the United States Government", April 1, 1990 - March 31, 1991, sets out guidance for regulatory impact analyses. One of the guidelines deals with discounting the monetary values of benefits and costs occurring in different years to their present value so that they are comparable. Historically, the agency has discounted future benefits and costs when they were monetary in nature. For example, the agency has discounted future increases in fuel consumption due to the increased weight caused by safety countermeasures, or decreases in property damage crash costs when a crash avoidance standard reduced the incidence of crashes, such as with center high-mounted stop lamps. The agency has not assigned dollar values to the reduction in fatalities and injuries, thus those benefits have not been discounted. The agency performs a cost-effectiveness analysis resulting in an estimate of the cost per equivalent life saved, as shown on the previous pages. The guidelines state, "An attempt should be made to quantify all potential real incremental benefits to society in monetary terms of the maximum extent possible." For the purposes of the cost-effectiveness analysis, the Office of Management and Budget (OMB) has requested that the agency compound costs or discount the benefits to account for the different points in time that they occur.

There is general agreement within the economic community that the appropriate basis for determining discount rates is the marginal opportunity costs of lost or displaced funds. When these funds involve capital investment, the marginal, real rate of return on capital must be considered. However, when these funds represent lost consumption, the appropriate measure is the rate at which society is willing to trade-off future for current consumption. This is referred to as the "social rate of time preference," and it is generally assumed that the consumption rate of interest, i.e. the real, after-tax rate of return on widely available savings instruments or investment opportunities, is the appropriate measure of its value.

Estimates of the social rate of time preference have been made by a number of authors. Robert Lind[1] estimated that the social rate of time preference is between zero and 6 percent, reflecting the rates of return on Treasury bills and stock market portfolios. Kolb and Sheraga[2] put the rate at between one and five percent, based on returns to stocks and three-month Treasury bills. Moore and Viscusi[3] calculated a two percent real time rate of time preference for health, which they characterize as being consistent with financial market rates for the period covered by their study. Moore and Viscusi's estimate was derived by estimating the implicit discount rate for deferred health benefits exhibited by workers in their choice of job risk.

---

[1]Lind, R.C., "A Primer on the Major Issues Relating to the Discount Rate for Evaluating National Energy Options," in <u>Discounting for Time and Risks in Energy Policy</u>, 1982, (Washington, D.C., Resources for the Future, Inc.).

[2]J. Kolb and J.D. Sheraga, "A Suggested Approach for Discounting the Benefits and Costs of Environmental Regulations,: unpublished working papers.

[3]Moore, M.J. and Viscusi, W.K., "Discounting Environmental Health Risks: New Evidence and Policy Implications," Journal of Environmental Economics and Management, V. 18, No. 2, March 1990, part 2 of 2.

Four different discount values are shown as a sensitivity analysis. The 2 and 4 percent rates represent different estimates of the social rate of time preference for health and consumption. The 10 percent figure was required by OMB Circular A-94, until October 29, 1992. The 7 percent figure is the current OMB requirement, which represents the marginal pretax rate of return on an average investment in the private sector in recent years.

Safety benefits can occur at any time during the tire's lifetime. For this analysis, the agency assumes that the tires are purchased in the beginning of year 5 for a typical passenger car or light truck and used for an average 45,000 miles. Table VII-3 shows the estimated distribution of miles traveled for a typical new tire purchased, and the weighted discount factor for benefits of 0.873.

Table VII-3

Year	Miles Traveled	Discount Factor	Total Discount Factor
1	11,392	.9667	11,013
2	10,979	.9035	9,920
3	10,581	.8444	8,935
4	10,198	.7891	8,047
5	1,850	.7375	1,364
Total	45,000		39,279/45,000 = 0.873

This value (0.873) is multiplied by the equivalent lives saved to determine their present value (e.g., in Table VII-2 (45 x .873 = 39). The net costs per equivalent life saved for passenger cars and light trucks are then recomputed and are shown below.

Net Cost/Equivalent Fatality After Discounting by 7 Percent

$282 mil/39 equivalent fatalities = $7.2 million per equivalent life

It must be emphasized that not all benefits could be quantified. The agency believes there will be other benefits that could not be quantified currently from the aging test and overloading of vehicles, that there potentially could be large benefits from the low tire inflation test, and that there will be some small benefit from the puncture resistance test and the de-beading test.